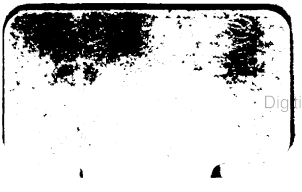
FIRST ANNUAL REPORT

OF THE

STATE ENTOMOLOGIST

OF INDIANA

1907-1908



Luna Moth.

FIRST ANNUAL REPORT

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OF INDIANA

BENJAMIN W. DOUGLASS

1907-1908

INDIANAPOLIS:
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING,
1908.

Indiana State Library

THE STATE OF INDIANA,
EXECUTIVE DEPARTMENT,
November 9, 1908.

Received by the Governor, examined and referred to the Auditor of State for verification of the financial statement.

OFFICE OF AUDITOR OF STATE,
INDIANAPOLIS, November 17, 1908.

The within report, so far as the same relates to moneys drawn from the State Treasury, has been examined and found correct.

J. C. BILLHEIMER,
Auditor of State.

Transferred from Library. Replaced by another copy.

November 18, 1908.

Returned by the Auditor of State, with above certificate, and transmitted to Secretary of State for publication, upon the order of the Board of Commissioners of Public Printing and Binding.

L. K. BABCOCK,
Secretary to the Governor.

Filed in the office of the Secretary of State of the State of Indiana, November 18, 1908.

FRED A. SIMS,
Secretary of State.

Received the within report and delivered to the printer November 18, 1908.

HARRY SLOUGH,
Clerk Printing Bureau.

Financial Statement.

1907.

Salary Benjamin W. Douglass	$453 04
Salary Elsie Dickson	165 00
Stenographer	40 00
Hotel	46 25
Transportation	51 60
Postage	147 00
Livery	35 75
Express	37 20
State Fair expenses	45 75
Office and Laboratory equipment and supplies	542 15
Telegram	25
Telephone	10 00
	$1,573 99
Excess on warrant for June, 1907, due to clerical error	2 50
	$1,576 49
Deficit on warrant for August, 1907, due to clerical error	90
Total expenditures	$1,575 59

This report covers only a portion of the fiscal year from the time of the appointment of the present Entomologist in June, 1907, to the end of the year, September 30, 1907. The former occupant of the office failed to turn over any office records or accounts of any kind, and the above report does not include any expenditures which may have been made by him.

1907-1908.

Salary Benjamin W. Douglass	$1,500 00
Salary Elsie Dickson	720 00
Transportation	149 62
Hotel	106 85
Livery	126 80
Office and Laboratory equipment and supplies	384 06
Express	6 47
State Fair expenses	91 25
Postage	70 00
Field work	15 00

Telegrams	$1 17
Telephones	78 30
Total	$3,249 52
Returned to State on account of voucher for August, 1907	2 50
Actually received from the State	$3,247 02
Appropriation for the year	$3,500 00
Expenditures for the year	3,247 02
Returned to the State	$252 98

Letter of Transmittal.

HON. J. FRANK HANLY, *Governor of Indiana:*

MY DEAR SIR—It is my pleasure to present herewith the manuscript for my first report, as I am authorized to do under the act creating this office.

The report deals with the inspection work of the office since its organization under the present law, and in addition it discusses at some length many of the economic insects and plant diseases to be found in Indiana.

The numerous illustrations are regarded as essential for the proper understanding of the text.

Respectfully,

BENJAMIN W. DOUGLASS.

November 9, 1908.

Nursery Inspection.

1907.

The nursery inspection for 1907 started immediately after the appointment of the present Entomologist, on the tenth of June, 1907. For a few weeks the field work was necessarily slow owing to the entire lack of organization in the department, which necessitated considerable office work. There were found to be no office records of any sort and the only list of nurseries obtainable was one published by the State Horticultural Society in 1905. This list was subsequently found to be very inaccurate and of the 161 names it contained, only 123 were found to be still in the nursery business.

Early in the inspection work it was realized that a large percentage of the nurseries of the State were infested with injurious insects or fungus diseases. In many cases the conditions were such as to be easily remedied by a little intelligent work, but until that work was done no certificate for the sale of stock could be issued. Consequently we had to provide some means whereby the nurseryman could clean up his stock and subsequently receive his certificate. Reinspection of each infested nursery was not practical, so an affidavit system was designed to cover the emergency. Wherever a place was found to be in an unsatisfactory condition orders were issued to the owner to carry out a certain line of work looking to the eradication of the trouble. When this work was completed the following affidavit was filled out and filed in this office and the nursery certificate was issued.

STATE OF INDIANA, COUNTY OF ..... ss.:

I, ..., being duly sworn upon oath, make affidavit that, as the legal owner of a nursery situated in ....., I have carried out or caused to be carried out, the following work prescribed by the State Entomologist, to wit:

.....

.....

.....

.....

I further state under oath that the above work has been carefully and conscientiously performed and to the best of my ability. I judge it to be effective for the purpose prescribed.

....., 190

(Signed) .....

.....

Notary Public.

My commission expires

.....

Whenever the San Jose scale was found the owner was required to fumigate his stock before selling it. In a few cases where the advent of the scale was recent and was confined to restricted areas the owners were required only to destroy the infested stock.

During the season's work thirty-one nurseries were found to be infested with San Jose scale, while ten were infested with scales other than the San Jose. Of these minor scales the Scurfy was the most common and in some instances was doing considerable damage. A few infestations of Oyster Shell scale were found, usually associated with the more dangerous San Jose.

The season of 1907 was an especially favorable one for the plant lice and in eight nurseries these insects were doing serious damage. In four nurseries borers of various kinds occurred in injurious numbers. One nursery in particular was so badly infested with peach borers that we were compelled to refuse a certificate on the stock.

Later in the season a critical examination was made of a few hundred selected trees and a part of the stock was passed.

Of the plant diseases the Crown gall was the worst encountered, being present in a great many nurseries. In five places it was so serious that considerable blocks were ordered destroyed.

Pear blight was found doing some damage in two nurseries.

At one place a large orchard nearly dead from Peach Yellows was ordered burned. The adjacent peach stock showed no signs of the disease and as all of the buds had been imported from a yellows-free district the stock was passed.

A serious disease of the apple trees was noted in three nurseries. This was what we have called the "Apple Stem Fungus" and is caused by a parasitic plant belonging to the genus Nectria. It is more fully discussed elsewhere in this report.

Considerable orchard inspection work was carried on in connection with the nursery inspection though there was no time for systematic effort along this line. Many farmers were anxious to have their places inspected and seemed to be willing to do whatever was suggested for the betterment of their orchard conditions. Many recommendations were made by correspondence and a large number of specimens mailed to the office were identified.

During the early summer of 1907 the first publication of the office was prepared and printed. This preliminary bulletin has had a wide circulation and has served its purpose in acquainting the public with the location and work of the office.

1908.

The nursery inspection work was formally started about the middle of May and progressed rapidly during the summer months.

The general methods of inspection were the same as the previous year though the examinations were perhaps more rigid—as they will tend to be with each succeeding season.

The regulations regarding the San Jose scale were made more severe and wherever this scale was found on the premises of any nursery fumigation was required.

The following fumigation blank was filled out by the owners of the infested nurseries and filed in this office before a certificate was issued:

"STATE OF INDIANA, COUNTY OF .....ss:

I, ..., being duly sworn upon oath do hereby make affidavit that, as the legal owner of a nursery situated in ....., I will not permit any stock (except conifers) to be removed in any way from my premises until such stock has been carefully fumigated according to the directions issued by the State Entomologist. I also make affidavit that all such fumigated stock, when offered to any railroad or transportation company for shipment, will be accompanied with a suitable label, stating that the stock has been fumigated."

(Signed) .....

.....

Notary Public.

My commission expires

.....

At the present writing there still remains some inspection work to be finished, but the majority of the nurseries visited show a distinct improvement over their condition last year.

There was a noticeable improvement, not only in the smaller number of injurious insects found, but in the general cultural condition of the places visited.

Of the twenty-one nurseries found to be infested with San Jose scale several were recent infestations that had either occurred since the last inspection or had been overlooked at that time.

Five nurseries were found to be infested with scales other than the San Jose. Two of these places were new additions to the nursery list and had never been visited before.

Plant lice were found in injurious numbers in only one nursery.

In two places the Bagworm moth was damaging apple stock so badly that treatment was required. This is one of the few leaf-eating insects that can be distributed on nursery stock.

Five nurseries were infested with Crown gall to a noticeable extent though no case was as serious as any one of the five reported last year.

Sphaerotheca panosa, a fungus disease of the foliage and stems of the peach, was exceptionally bad in five nurseries. One nursery devoted exclusively to the sale of peach trees was so badly infested with this disease that the trees were unsalable and a certificate for their sale was refused.

Black knot of the plum was damaging stock in only one nursery.

Pear blight was also found in but one place.

Apple Orchard on the Grounds of the Southeastern Hospital for the Insane at Madison, Indiana. Used by this office for Experimental Work against the San Jose Scale.

The fungus Nectria was not noted in any of the nurseries examined up to the present time and it is hoped that it has been completely eradicated from the places where it did occur.

More attention was given to the inspection of small fruit plants than last year. The anthracnose of the raspberry was found to be a serious pest in many places and the root louse of the strawberry was found to be more widely injurious than was expected. Experiments are now being conducted to find a method of treating infested strawberry plants and next year strawberry plant beds will be much more rigidly inspected than they have been heretofore.

During the spring of 1908 blanks were sent to all of the nurseries in the State in an attempt to secure some idea of the extent of the business and the amount of money actually involved in it.

Replies were received from about seventy growers and from these replies the following data has been gathered:

The nurseries of the State vary in size from a few trees to three hundred acres. The total acreage devoted to nursery stock in the State is 1,222 acres, from which there are annually sold 1,169,300 trees valued at $157,000.00.

It must be remembered that these figures are based on rather incomplete returns, as many of the nurserymen objected to filling out the blanks lest they might in some way say something that would injure their business.

The following list includes all of the names on our official inspection list for 1908:

J. M. Alstott, Corydon, Ind.
J. K. Anglin, Etna Green, Ind.
H. Back and Son, Harrison, O.
T. A. Baldwin, Oxford, Ind.
M. Barnes and Co., Groesbeck, O.
E. H. Bell, Richmond, Ind.
A. S. Bennett and Son, Lafayette, Ind.
Samuel Billingsly, Greenwood, Ind.
Mrs. W. C. Bennett, Scotland, Ind.
M. M. Bowman, Pennville, Ind.
R. W. Bowman, Pennville, Ind.
The Bremen Nursery Co., Bremen, Ind.
J. M. Bridges, Dugger, Ind.
Mercer Brown, Spiceland, Ind.
Brownstown Nursery Co., Brownstown, Ind.
H. F. Buck, Elberfeld, Ind.
W. P. Bundy, Dunreith, Ind.
J. S. Burgess, De Pauw, Ind.
Warren Burgo, Retreat, Ind.
Burkhart and Son, Southport, Ind.
Capital City Nursery Company, Indianapolis.
P. A. Card and Son, Greenfield, Ind.
Alva Cathcart, Bristol, Ind.
Herbert Cavanagh, Wolcottsville, Ind.
Lamar Collins, Lexington, Ind.
L. B. Cochran, Greensburg, Ind.
J. L. Cook, Warsaw, Ind.
J. H. Cunningham and Son, Rising Sun, Ind.
H. P. Dean, Greenwood, Ind.
J. W. Dickey and Co., Doans, Ind.
C. L. Dixon, Bloomfield, Ind.

J. L. Doan, Westfield, Ind.
H. C. Eickhoff, Julietta, Ind.
O. Engler, Walton, Ind.
Gip Evans, Carmel, Ind.
J. W. Everett, Butler, Ind.
F. A. Forbes, Plymouth, Ind.
William Forcum, Wadesville, Ind.
J. M. & C. B. Fudge, Muncie, Ind.
W. H. Gaar, Germantown, Ind.
Gainey and Hostetter, Doans, Ind.
D. M. Garber, Pierceton, Ind.
F. B. Garrett, Burns City, Ind.
Hugh V. Goble, Greenfield, Ind.
Albert Goehler, Urbana, Ind.
Golden Rule Nursery, Bluffton, Ind.
J. K. Graham, New Albany, Ind.
Alvia Gray, Pekin, Ind.
Warren C. Gregg, Pennville, Ind.
J. C. Grossman, Wolcottsville, Ind.
E. R. Gustin, Peru, Ind.
Harry Haas, Terre Haute, Ind.
Joseph Haines, Lake, Ind.
Halleck Nursery Company, Fair Oaks, Ind.
A. J. Harruff, Salamonia, Ind.
Smith Hazen, Rockport, Ind.
J. W. Heacock, Salem, Ind.
Henby and Son, Greenfield, Ind.
H. W. Henry, Laporte, Ind.
George T. Hoagland, Portland, Ind.
C. M. Hobbs and Son, Bridgeport, Ind.
J. H. Holsclaw, North Vernon, Ind.
J. H. Hoppes, Red Key, Ind.
J. H. Huber, Ridgeville, Ind.
H. E. Jackman, Waterloo, Ind.
J. A. Jarrett, Montpelier, Ind.
S. W. Keplar, Pulaski, Ind.
Ben Knaub, North Vernon, Ind.
Vernon Krider, Middlebury, Ind.
William LaHayne, Chesterton, Ind.
J. W. Lucas, Bloomfield, Ind.
O. Lutes, Portland, Ind.
Mart Suhm and T. S. Lutes, Portland, Ind.
William McElderry, Princeton, Ind.
D. A. McGinnis, Andrews, Ind.
Samuel McKinley, Borden, Ind.
B. F. Mason, Martinsville, Ind.
McClaren and Son, Corydon, Ind.
J. E. McCoy, Bourbon, Ind.
M. F. McFarland, Bloomington, Ind.
Hiram McFeron, Columbus, Ind.

H. H. Meeker, Crown Point, Ind.
Meredith and Son, Koleen, Ind.
Jesse Milhouse, Butlerville, Ind.
Grant Mills, Portland, Ind.
Henry Minnick, Converse, Ind.
Frank Moffett, Carmel, Ind.
H. E. Moon, Portland, Ind.
C. B. Moore, Monticello, Ind.
G. N. Moyer, Laketon, Ind.
A. M. Murray, Goshen, Ind.
Charles Nation, Gilead, Ind.
Henry Ogden, Elizabethtown, Ind.
J. C. Overman and Son, Raysville, Ind.
R. T. Patterson, Bloomfield, Ind.
George Paxton and Son, Pennville, Ind.
C. C. Pennington, North Vernon, Ind.
J. A. Phillips, Bloomfield, Ind.
Portland Nursery Company, Portland, Ind.
Amos Ragle, Elnora, Ind.
Randolph Nursery Co., Lafayette, Ind.
W. C. Reed, Vincennes, Ind.
W. H. Reed, Hanover, Ind.
W. A. Ripley, Willshire, O.
Lee Ripperdan, Valley City, Ind.
Sig Rogers, Bloomfield, Ind.
Rutherford and Evans, Bluffton, Ind.
H. C. Semon, Vernon, Ind.
Shields Brothers, Charlottsville, Ind.
Thomas Shields, Anderson, Ind.
A. B. Sibert, Rochester, Ind.
Simpson and Sons, Vincennes, Ind.
Sleeper Brothers, Fowler, Ind.
E. E. Smith, Warsaw, Ind.
W. S. Smith, Battle Ground, Ind.
J. M. Snodgrass, Kirklin, Ind.
The Snoddy Nursery Company, West Lafayette, Ind.
W. E. Stacey, Lyons, Ind.
Wilbur Stout, Mooresville, Ind.
H. H. Swaim, South Bend, Ind.
E. Y. Teas Co., Centerville, Ind.
G. W. Truex, Lockman, Ind.
F. Walker and Co., New Albany, Ind.
Thomas Ward, St. Mary's, Ind.
J. W. Wickizer, Plymouth, Ind.
J. W. Wilson, North Judson, Ind.
G. W. Winchell, Tobinsport, Ind.
Carl Weber, Greenfield, Ind.
George C. Young, Greensburg, Ind.

Apple Tree badly crusted over with San Jose Scale. Notice the uniform gray appearance of the Trunk and Branches.

The Control of the San Jose Scale.

The San Jose scale question is one which has attracted wide attention from the general public during the past ten years. It has, in fact, been so conspicuous in the public eye that the science of economic entomology has acquired a popular reputation based largely on this one insect. Other forms of equal or greater economic importance are accepted as a matter of course, but the San Jose scale being a species of rather recent introduction and coming at a time when newspaper publicity is easily obtained, has rapidly assumed the leading position among American economic insects.

In the control of any insect there are three general factors involved: nursery inspection to prevent the distribution of infested stock; individual work by private individuals where an insect has become established; and the natural control of parasitic enemies.

In Indiana the nursery inspection for 1907 (the first season under the present management) revealed the fact that over thirty nurseries were infested with the San Jose scale. Some of these places had had the scale for several years, and it can easily be seen how they would be active agencies for the distribution of the pest. In many cases the nurserymen were ignorant of the existence of the insect on their grounds, and were glad to do all in their power to eradicate the trouble. Where the scale occurs on the stock or is liable to get on the stock from infested trees in the neighborhood, we require all stock sold to be fumigated with hydrocyanic acid gas of sufficient strength to kill the scales. This work, if properly done, does not injure the stock in any way, and the only objection which can be made to the treatment is on the part of the nurseryman, who, for financial reasons, prefers to sell his stock unfumigated. At the present time in this State all the nurseries infested with San Jose scale are required to file an affidavit in the office of the State Entomologist stating that they will fumigate, according to our published directions, all stock sent out from their premises and that all such stock shall be plainly labeled to the effect that it has been fumigated.

The second step in the control of this pest is private work by individuals in localities where the scale has become established.

Apple Tree infested with San Jose Scale before being Trimmed preparatory to Spraying.

This at once raises the question as to whether or not the State can afford to undertake the general work of spraying trees or whether it is practical to make some regulation in regard to compulsory spraying by individuals.

Many owners of orchards are willing to spray their trees, but complain that "the man on the next farm has scale and won't spray, so what can I do?" They might just as reasonably ask the same question in regard to the codling moth, the apple scab, bitter rot, or any other fruit disease. And yet no up-to-date apple grower would attempt to grow apples without spraying and spraying regularly for the troubles mentioned. There is practically no commercial orchard section in the country (except Maine) where the San Jose scale is not a recognized pest.

And we are often told by growers in these sections that the San Jose scale is one of the most easily controlled insects which they have to contend with. One good spraying each year, or perhaps each two years, and their trees are kept clear of scales—while to control the codling moth they must spray each year, not *once*, but perhaps *six* or *eight* times. In spite of this ease of control of the San Jose scale it has already become so widely distributed over the State that to attempt its *extermination* would be to attempt an impossible task. I do not believe that the San Jose scale will ever be exterminated any more than the codling moth will be exterminated, but it will be controlled in the same way that the moth is controlled.

The problem of the control of the San Jose scale differs from that of the codling moth only in magnitude. The moth is of importance to only a few men in each locality who are growing apples, and most of them are thoroughly conversant with the means of control of this insect. The San Jose scale is of importance not only to the occasional orchardist, but to every landowner, no matter how small, who has a few trees on his place. It thus becomes an educational work of vast dimensions and immense importance.

In addition to the necessary work along educational lines the office of the State Entomologist should have the authority to require spraying wherever it is needed, not that I consider compulsory work an efficient *substitute* for a systematic campaign of education, but as an important adjunct to it. There is a certain class of citizens who can be educated only with a club, and a law similar to what we now have would prove an effective club in the hands of the State Entomologist if there were any funds with which to enforce it. Under the present statutes the State Entomologist does

Apple Tree shown on page 18 after being properly Trimmed preparatory to Spraying.

not have the power to use deputies (except for certain restricted purposes), and after the nursery inspection is completed there remains but little time in which to give attention to the systematic educational work. Given the authority to use deputies and the funds to pay them, this office would be equipped to handle the question of the control of the San Jose scale, throughout the State, in the most effective manner, and at the least expense to the commonwealth.

In some localities where educational work was carried on last winter I have had most encouraging reports relative to the results obtained. Educational work of a scientific nature always meets with more or less opposition from the ignorant and the superstitious and there has been the usual amount of obstruction of this sort to be overcome. A case in point will illustrate:

A party living north of Indianapolis called on the State Entomologist last winter for advice relative to a peach orchard badly infested with San Jose scale. After an examination was made our recommendation was to cut the trees back and spray them with the standard lime-sulphur-salt wash. While the orchardist was carefully carrying out the work a neighbor who posed as an "old hand" at the fruit business came over to witness the operation and expressed the opinion that if the trees were sprayed with lime-sulphur-salt wash "they would all die." Fortunately the orchardist's faith in the official recommendation held good and the trees not only did not die, but lived to bear the best fruit in the neighborhood.

This one case has served as an object lesson in that locality, and during the coming winter many of the neighbors intend spraying their trees systematically. With a small force of efficient deputies for such work an inestimable amount of good could be accomplished.

The question of the methods of fighting the San Jose and other scales will be taken up in detail along with other matters relative to spraying, at the end of this chapter.

The third step in the control of the San Jose scale is one which nature takes and it is one that has been watched and studied with considerable interest. In their native lands practically all insects are controlled by some other insect parasite. As long as the San Jose scale remained at home in northern China it never had much opportunity for doing harm, owing to the fact that it was considered a delicacy by a certain Chinese lady bug, but as soon as it got into new countries, far removed from this predaceous celestial insect, it became the serious pest which we know today. It would seem to be a simple matter to import a few of these parasitic beetles and turn them loose in our infested orchards, but while such im-

Badly Infested Apple Tree which was Cut Back in the Spring of 1908. During the Summer a vigorous growth of Sprouts was made. These Sprouts were Thinned Out as is shown on page 24.

portations have been made I do not know that there is any record of the successful establishment of a single colony of the lady bugs anywhere in the country.

In Indiana there are at least two species of lady bugs that are known to feed partly on the San Jose scale. Of these the most common and by far the most important is the Twice Stabbed lady bug (Chilocorus bivulneris). This insect feeds on the San Jose scale to the exclusion of other food whenever possible, and I have sometimes seen trees practically freed from the scale by their work. During the last two seasons these insects have seemed to be steadily increasing, and it may be that they will eventually prove an important factor in our great scale problem. Last spring there were many of these beetles, in the larval stage, sent to the office for identification. The small black spiny larva do not in any way resemble the adult lady bug, and doubtless many of them were killed by people who were under the impression that the creatures were noxious insects.

I was much interested in the work of the Twice Stabbed lady bug in the orchard of the Southeastern Hospital for the Insane, at Madison, last spring. The orchard was badly infested with San Jose scale, and only a part of it was sprayed before the rapidly opening buds rendered spraying impossible. The sprayed trees, on which most of the scales were killed, were almost entirely free from the beetles, while on the unsprayed trees they were working in great numbers.

It is important that this insect (and other beneficial insects) should be protected as much as possible, and for that reason I have been pleased with some of the nature study work now being done in the Indianapolis schools. Among other outdoor studies the children are taught something about the common insects. Many of the children can recognize the various scales, and I was surprised at one sharp-eyed little girl of ten who visited the office recently and quickly recognized the Twice Stabbed lady bug in a box with two hundred other lady bugs. It spoke well, not alone for the native quickness of the child, but for the excellence of her training. Educational work of this sort is just as important to the present and future citizens as the rudimentary three R's were to their ancestors of a few generations ago, who lived in far more simple environments.

In the rapidly changing life about us we are forced constantly to alter our lives and our methods of work to suit the ever-changing conditions of existence. Changes are always occurring, not only in

Same Tree shown on page 22 after the weaker sprouts had been Cut Off. At the end of another Season these Sprouts will again be Thinned Out, leaving only the Strongest to form the Head of the Tree.

the artificially ordered lives of men, but in the very course of nature itself. Formerly it was possible to grow apples in Indiana without spraying and have them comparatively free from worms. It is true there were native tree pests, but they were so completely controlled by native parasites that they occasioned but little loss. The advent of the codling moth and its subsequent wide distribution marked a new era in the business of apple growing. Later the introduction of the San Jose scale marked still another stage in the war between mankind and the insect world, for the San Jose scale, like the codling moth, left its parasitic control behind it when it came to live on the new pasturage in America.

Had the United States Department of Agriculture existed in its present state of efficiency one hundred years ago the codling moth would have been exterminated when it first came to us from the orchards of Europe. Had Indiana possessed a fair system of nursery inspection fifteen or twenty years ago the San Jose scale could never have found a foothold within our boundaries.

Our work to day consists not only in meeting the conditions of the present brought about by the carelessness of the past, but in preparing to meet the conditions which are certain to arise in the future.

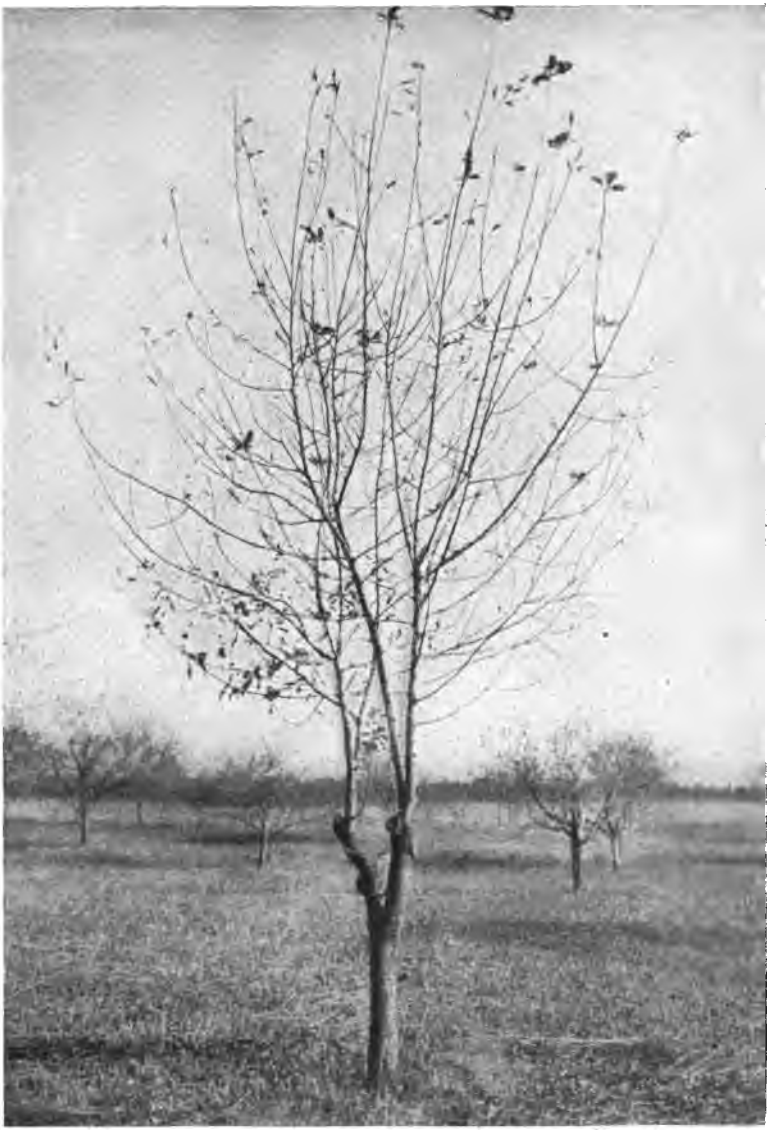
In the matter of the control of the San Jose scale or any other insect the office of the State Entomologist must be considered not simply as a police department for the inspection of nurseries, but as a powerful educational institution whose work it is to keep the masses of the people informed on the increasingly important subject of entomology.

METHODS OF SPRAYING.

The first important thing about the question of spraying is to know what you are going to spray for.

Many people over the State have conceived the idea that "spraying" is a specific term and applies to only one sort of application—the kind they themselves have been using. After all the information that has been printed about this subject I was surprised to find one nurseryman using Bordeaux mixture for the San Jose scale.

"Spraying" is a decidedly generic term, and applies horticulturally to three different general processes. The first class of spraying operations deals with the contact insecticides—those solutions



Apple tree cut back five years ago, showing the rapid formation of a new head under this system of treatment.

which are designed to kill insects by contact. Such insects are the scales, the plant lice, and the true bugs; all of which obtain their food by sucking the juice of the plant on which they feed.

The next class of spraying materials includes those poisons that are applicable to the insects which get their food by eating the plant tissue. As a rule some preparation of arsenic is used for this purpose—the most common preparation being paris green.

The third class of spraying operations includes the work against the various fungus enemies of plants. For this purpose some solution of copper is usually used. Often the fungicide has added to it some preparation of arsenic, thus making it effective against both chewing insects and plant diseases.

These various spraying materials will now be dealt with in detail in the order mentioned.

CONTACT INSECTICIDES.

The lime-sulphur-salt wash easily stands first among the contact insecticides for it is the most effective solution which we have for use against the scale insects. It is designed primarily for winter work, as it is so caustic in action as to be almost fatal to any kind of foliage.

The following formula is one that has been thoroughly tested by this office, and is entirely reliable:

Lime	50 pounds
Sulphur	50 pounds
Salt	50 pounds
Water	150 gallons

Add enough water to the lime to slake it thoroughly and immediately add the sulphur. Boil for an hour or so with only water enough to keep the mass liquid until the solution becomes a deep amber color. Have the salt dissolved in water and add to the boiling mass. After it has all been mixed together boil for at least another hour, and then add water enough to make up the one hundred and fifty gallons and spray it as soon as possible. It is more efficient when used warm, and some of the failures with this wash have undoubtedly been due to the use of stale solutions and to careless boiling.

One objection to this wash is that it is decidedly "messy" to work with, and the man at the spray pump is certain to ruin his clothing, and is fortunate if he keep the spray from his eyes, which will cause serious inflammation. It is always advisable with this, or

any other spray, to wear very old clothing that will never be used for any other purpose and to protect the hands and face in some way. Automobile goggles would serve admirably to keep the spray from the eyes.

There has been some discussion lately relative to the use of salt with the lime-sulphur mixture. It is claimed that the salt tends to draw moisture from the atmosphere and to keep the sprayed branches in moist condition favorable to fungous growth. In my own work I have not noticed this to be the case, and the contention seems to me to be a trifle far-fetched. On the other hand, the salt seems to add but little to the insecticidal value of the solution, merely increasing its adhesive properties and causing the wash to remain longer on the tree.

The lime-sulphur-salt wash is universally recommended for use against the San Jose scale and other scales, and before I leave this chapter I want to say a few words about the actual work of spraying (and preparing to spray) infested trees.

Spraying for any of the scale insects must be very thorough in order to be effective. On an infested tree the individual scales will extend far out to the tips of the smallest branches and will be very difficult to reach even by the most thorough work. For this reason it is almost necessary for the upper, small, branches to be cut back. When a tree is so badly infested that the upper portion of it is noticeably weakened or shows a tendency to die back, it should be trimmed mercilessly and from the remaining stumps be given an opportunity to grow a new head.

A tree stumped back can readily be entirely freed from scales, whereas on a tree with many small branches there are ample opportunities for stray scales to escape the action of the insecticide. These points are more fully developed in the pictures which accompany this chapter.

All of the branches which are taken off of the tree should at once be carted out of the orchard and burned.

In spraying always work with the wind even if it necessitates two sprayings from opposite directions in order to fully cover a tree from all sides.

THE SELF-BOILED LIME-SULPHUR WASH.

This wash is prepared from the same materials as the preceding, but instead of applying artificial heat, the heat of the slaking lime is used to bring the sulphur into solution. The resulting mix-

ture does not possess so high an insecticidal value and is mild enough in its action that it can be used for spraying even when trees are in full foliage. In some places it has given excellent results as a fungicide, being especially useful in spraying peaches, on which copper preparations can not be used. During the coming year I hope to be able to test this material fully, both as a summer spray for the San Jose scale and for use against fungous diseases.

It is prepared as follows:

Place 15 pounds of fresh stone lime in a fifty gallon barrel and pour three gallons of boiling water over it. At once add ten pounds of sulphur and three more gallons of hot water. This will boil vigorously for several minutes, and if it shows signs of sticking or burning it should be stirred and more hot water added. The boiling will continue for twenty minutes or more, and when it stops the barrel should be filled up with cold water and the spray used at once. Always strain all lime-sulphur mixtures before putting them in the spray tank.

COAL OIL EMULSION.

The following formula for kerosene emulsion is from Professor J. B. Smith's Economic Entomology:

Hard soap shaved fine	½ pound
Water	1 gallon
Kerosene	2 gallons

Dissolve the soap in boiling water; warm the kerosene and add the boiling hot suds to it; then churn with a force pump for a few minutes and we get first a milky appearance, which yields rapidly to a cream, and this to a soft butter-like mass. When cold it will adhere to glass without oiliness and the emulsion thus made, containing 66 per cent of kerosene, will remain unchanged for some time, and may be mixed with water to any extent. Soft water must be used for best results, and with very hard water a real emulsion can not be obtained at all without the addition of borax sufficient to soften it. Diluted from nine to ten times this emulsion is very effective against plant lice, many scale insects, and such others as yield to contact insecticides in general. Plants vary in their resistance to this material, not only absolutely, but relatively under different climatic conditions. Diluted nine times, few insects resist its effects and only the hardier plants can be safely treated; diluted fifteen times, only the green plant lice are affected, while

some foliage shows material injury. Where plants do not readily stand a dilution of twelve times it is better not to use the emulsion at all. for winter use the emulsion is useless as against dormant scales, and more injurious to trees than the undiluted oil."

MISCIBLE OILS.

The so-called "miscible" or "soluble" oils are simply convenient preparations of some heavy oil mixed with a "cutting" agent, to cause the oil to spontaneously emulsify when mixed with water. There are a number of these preparations on the market under the names of Target Brand, Scalecide, Liquid Soap, etc. All of them seem to possess considerable value and they are certainly more convenient and pleasant to work with than either the lime-sulphur-salt wash or the coal oil emulsion. As a rule, however, it is a good plan to use these oils considerably stronger than the directions call for. Ordinarily the strength recommended for winter spraying is one part of oil to twenty parts of water. Better results will be obtained by the use of fifteen or even twelve parts of water to one of oil.

I have found these proprietary scalecides especially valuable for summer use against the various plant lice and even against some of the scale insects. Diluted with thirty parts of water, but little foliage will be injured and plant lice will be readily killed and even the San Jose scale can be considerably checked. In June of 1908 I sprayed a small peach tree twice with Scalecide diluted with twenty parts of water. At the time some branches of the tree were so badly infested with San José scale that the leaves were falling and the fruit drying up. During the summer the tree has been repeatedly examined and no live scales have been found. In September about half a bushel of excellent fruit was gathered and at this time (October) I do not believe there is a live scale left on the tree.

The chief objection to the miscible oils is that they are so expensive that the commercial orchardist can not consider them against the cheap and effective lime-sulphur-salt. While they can be made at home for about half the ordinary wholesale price, the process is so complicated and so dependent upon the quality of materials that I would hesitate to advise any horticulturist to undertake the work.

For small spraying operations, however, they do possess a distinct value and should be widely used.

Spraying Fruit Trees in a Small City Back Yard. At the time this picture was taken the peach tree shown was badly infested with San Jose Scale. It was sprayed twice during the month of June, and in September half a bushel of fine fruit was gathered from the tree. Up to the present time no live scales have been found on the tree.

TOBACCO.

As a mild contact insecticide tobacco possesses distinct value and may be used in a variety of ways. For plant lice a solution may be made by boiling stems or refuse in the proportion of one pound of stems to a gallon of water. This solution is not injurious to foliage except when it is very young. Tobacco dust is often useful against plant lice, and certain slimy larva commonly called slugs. It can be used freely without danger of injury to the plants.

Coarse ground tobacco may be used around the roots of any plants infested with aphids, and it will have the double effect of an insecticide and a fertilizer. Certain Kentucky firms are now specializing in a complete fertilizer in which tobacco is the filler. Doubtless it will prove distinctly beneficial for root lice, cabbage maggots, grubs and similar root infesting insects.

STOMACH POISONS.

These poisons, usually preparations of arsenic, are used against insects which actually eat the tissues of the infested plant.

Paris green is discussed first as it has been long in use and is thoroughly reliable.

Paris green is widely used by orchardists in spraying for the codling moth and it has proved very effective for this purpose. The poison does not go into direct solution when mixed with water, and any spray tank for holding paris green mixture must be provided with some means of stirring the material, as it tends to settle rapidly. In mixing paris green a quantity of fresh lime, equal to two to three times the quantity of the poison, should be added to the solution to neutralize the free acid of the paris green. This precaution will not only prevent the possible burning of the foliage, but will cause the poison to adhere better.

In some localities experiments have been made with the use of paris green mixed with flour or dry lime and dusted on dry. After a careful review of a number of reports on this subject it would appear that the dust spraying was inferior to the wet process and was much more unpleasant to handle.

As a rule paris green should be used at the rate of one pound of poison to 100 or 150 gallons of water, though it is often used stronger than this. This violent poison can be more safely used on nearly ripe fruit or on such plants as cabbage than any of the other arsenic preparations as it is more easily washed from the plant

tissues by the rain. As a matter of fact, however, the poison is so diluted when it is applied that a man would have to eat an enormous quantity of fruit to get any effect from the arsenic.

ARSENATE OF LEAD.

This preparation is not as safe an insecticide as paris green, owing to the fact that it lacks the latter poison's characteristic color. It is valuable as an early spray for apple owing to the fact that it does not wash off the tree readily. It is also less liable to burn the foliage.

It is prepared as follows:

Arsenate of soda	20	oz.
Water	2 to 3	gallons
Acetate of lead	3½	pounds
Water	3	gallons

When the chemicals are dissolved the two solutions are mixed and water is added to make 100 gallons.

This preparation can be obtained on the market in paste form. Neither the home made arsenate nor the commercial is as cheap as paris green.

The systematic spraying of fruit trees and, more recently, in the East, of shade trees, has provoked considerable discussion in regard to the effects on birds and bees. The beekeepers have claimed that bees were poisoned and the Audubon Society has averred that the birds were being killed by eating poisoned caterpillars. Neither claim has any foundation in fact. No fruit tree spraying is done at the time of full blossoming, and the bees are not interested in the flowers at any other time. In the East, where extensive spraying operations are carried on against the gypsy and brown-tailed moths, it has been noticed that birds often completely disappeared from a community after the trees had been sprayed. Such a result was to be expected if the spraying was effective. The caterpillars, the food of the birds, were all killed, and our feathered friends simply moved on to better hunting grounds.

FUNGICIDES.

Of all fungicides Bordeaux mixture easily holds first place for general usefulness. It is universally employed by orchardists for the control of fungous diseases of fruit. It is ordinarily used in different strengths according to the development of the foliage.

The following formula is one that has given good results:

Bordeaux Mixture.

Copper Sulphate	6 pounds
Lime	4 pounds
Water	50 gallons

Dissolve the copper sulphate and the lime in separate vessels, using a couple of gallons of hot water for each. When dissolved add the lime slowly to the copper sulphate solution and then put in enough water to make up the full fifty gallons.

For winter work against plant diseases a simple solution of copper sulphate in water is useful. It can be used in the proportion of one pound to thirty gallons of water. This is valuable in the control of many diseases whose spores pass the winter on the trunk or limbs of the trees.

No solution containing copper should ever be used on the foliage of either the peach or the plum. This fact has led to the recent use of the self-boiled lime-sulphur wash for the control of peach diseases. As yet it has not been fully tested, but it promises to be a valuable addition to our list of fungicides. The directions for its preparation will be found under the Contact Insecticides.

FORMALIN:

Formaldehyde is obtainable in what is known as a "forty per cent solution." A pint of this commercial solution added to forty or fifty gallons of water makes an excellent disinfectant for the destruction of spores of the smut on oats and wheat. Place the grain on a clean surface that has been previously disinfected by a liberal application of the formaldehyde solution. Sprinkle the seed with the solution and cover with a heavy canvas or wet sheet and allow it to remain for two hours. The grain should be carefully dried before planting or before returning it to the storage bin. To accomplish this it should be shoveled over occasionally. All bins or sacks to which the grain is returned should be carefully treated with the solution to insure the destruction of any stray spores.

Formalin is also useful for the treatment of seed potatoes to destroy the spores of the fungus-causing scab. Soak the potatoes for two or three hours in a solution of one pint of 40 per cent formalin to 25 gallons of water.

Fumigation.

The question of fumigation for the extermination of insect pests is a large one, and must be dealt with in some detail in order that its full range of usefulness may be appreciated. To the nurseryman fumigation means simply the treatment of small trees to rid them from the San Jose scale. There are, however, many other applications of the process of fumigation, each of which will be taken up under a separate head.

FUMIGATION OF NURSERY STOCK.

During past years several different gases have been experimented with in the fumigation of trees to rid them of scale insects, but real success can be claimed for but one system of treatment.

This system has been proved so universally successful that the term fumigation as applied to nursery stock is commonly recognized to mean the exposure of the infested stock to the action of fumes generated when cyanide of potassium is acted upon by sulphuric acid. This chemical combination results in the liberating of what is known as hydrocyanic acid gas, one of the most deadly poisons known.

The laws of some States require that all stock sold or shipped into the State must be fumigated. Many States accept a fumigation affidavit in place of an inspection certificate, and some States require a statement of fumigation in addition to an inspection certificate. Considering the attitude toward fumigation in so many States it is necessary that the nurserymen who would transact business outside of Indiana should be prepared to treat their stock as may be required.

In Indiana some nurseries have been allowed a certificate only on condition that they fumigate all stock sold from their infested nurseries. During the summer of 1907 over thirty nurseries were found to be infested with San Jose scale. Some of these were small places that had practically been out of business for some time, and they preferred to discontinue the nursery altogether rather than make the effort to destroy their worst stock and fumigate the rest. A few of the places had very recent infestations in which it was possible to destroy all traces of the scale by removing a few trees. These places were, of course, not required to fumigate, but all other places in which there was any possibility of a general spread of

the scale were required to fumigate everything sold from their grounds.

During the season of 1908 there were but few new infested nurseries found, but the regulations governing fumigation were made more rigid than ever and the gas treatment was required wherever there was any reasonable possibility of the stock becoming infested, whether it showed the presence of the scale at the time of the inspection or not.

The fumigation of stock as described in this bulletin is not injurious to trees, and is completely effective in killing the San Jose scale and all other scales which do not pass the winter in the egg state. It is more effective and safer in its results than dipping or any similar process. In the spring of 1908 I planted a small orchard of apple. All of the trees were infested with San Jose scale and had been fumigated. Every tree grew except one, which died late in the summer as the result of the prolonged drought. At this writing, October, 1908, no scales have developed on any of the trees.

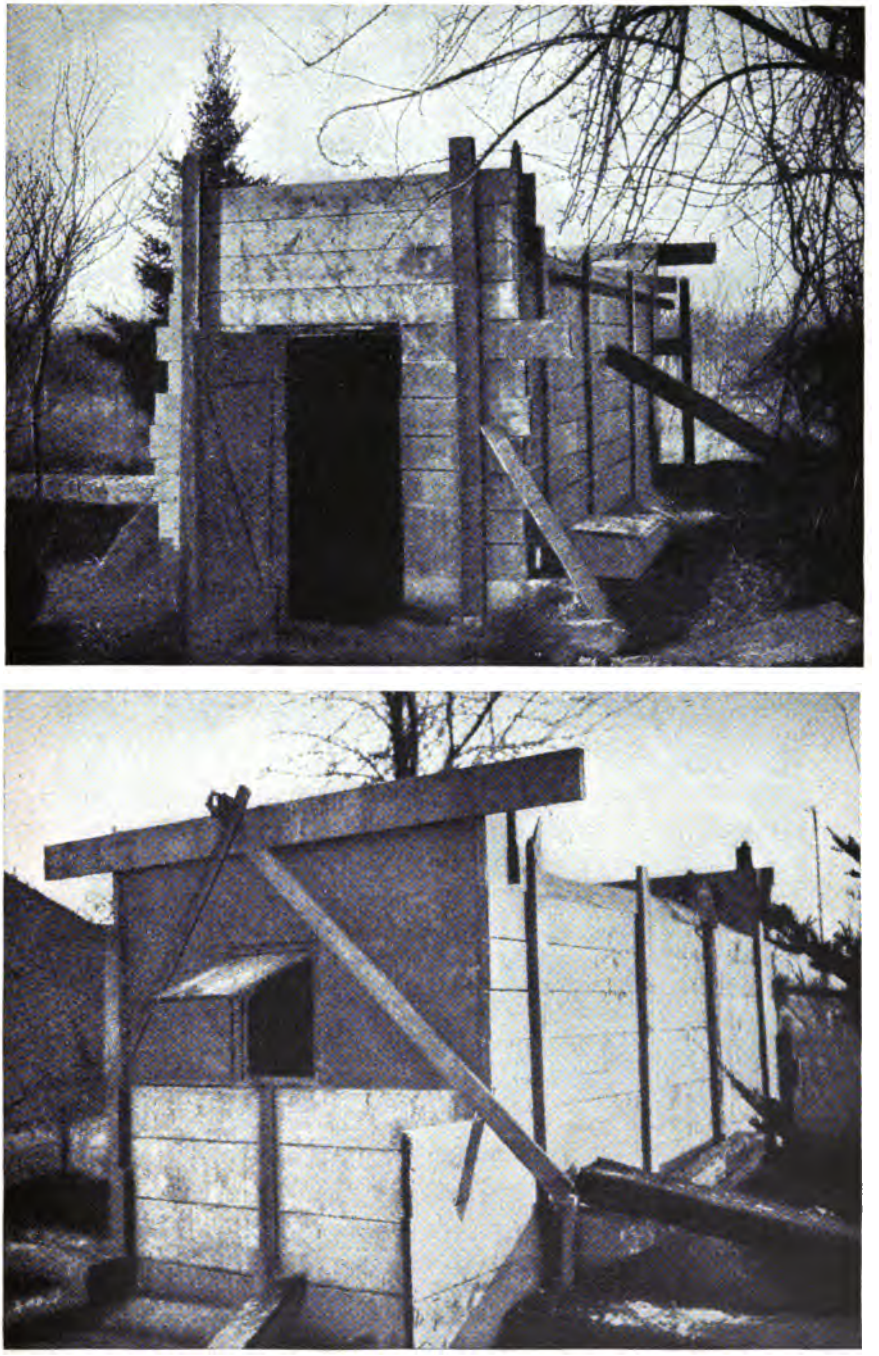
This same season I have had an opportunity to observe another lot of trees that were dipped in a one to twenty solution of one of the miscible oils. All of the trees have an unhealthy look; many of them have died. It should be said, however, that all of the San Jose scale seems to have been killed on them.

From a careful study of a large number of experiments in other States, as well as Indiana, I am convinced that where stock is infested with San Jose scale there is no substitute for the hydrocyanic acid gas fumigation, and the treatment will be required wherever an infested nursery is found.

THE FUMIGATING HOUSE.

The house in which the stock is exposed to the gas may be made according to the convenience of the nurseryman, but its walls and roof must be absolutely tight, and the door must fit perfectly and be provided with proper fastenings.

Some of the Indiana nurseries have built frame houses with two layers of matched boards, with building paper between, and they have given excellent results. Frame houses are cheaper in the initial cost, but cost more to keep in repair than do similar houses of stone, brick or cement. One of the latter will be described at length farther on. The poorest fumigation arrangements are those made by partitioning off the end or corner of a shed already in use for some other purpose. These fumigating rooms are nearly



Eickhoff's Fumigation House in Course of Construction.

always unsatisfactory, and at best are only to be considered as a makeshift until something better can be provided.

It is also a bad plan to attempt to build a "sectional" fumigating house. That is a house of large size that can be partly closed off so as to make a smaller room for the fumigation of a less number of trees. It is almost impossible to build the house so as to have the partition absolutely tight. It is a style of architecture to be avoided.

The fumigation house is an important building in the nursery and should always be kept in the best condition, ready for inspection at any time. Doors and windows must be kept closed in order to prevent the sagging and warping of them and it is best not to attempt to use the house for any other purpose. We have seen fumigating houses built in this State several years ago that have been used as poultry sheds the greater part of the year. They were absolutely unfit for the fumigation of trees.

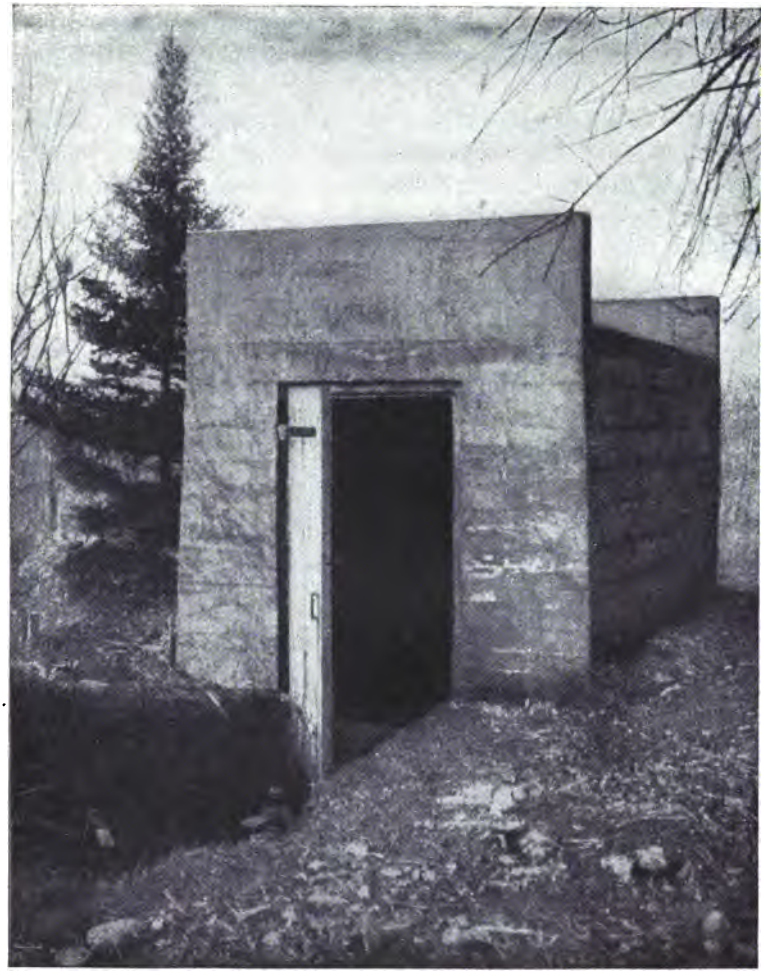
In the question of size the nurseryman must be governed entirely by his own requirements. The fumigation house erected last fall, under the direction of this office, by H. C. Eickhoff at Julietta, Indiana, is regarded as the best in the State and a model of its kind. It is made of reinforced concrete and the general structure is well shown in the accompanying cuts. The walls and the arched roof are nine inches thick. The door is of heavy oak and swings on long heavy iron hinges to prevent sagging. One opening is provided in the end opposite the door in order to procure quicker ventilation of the house. Had this window been placed closer to the roof it would have been better still, as the hydrocyanic acid gas is lighter than air and tends to rise to the top of the building. Placing the ventilation nearer the top would have allowed easy escape for all gas at the end of the exposure.

In order to avoid the outrushing poisonous gas, ropes have been provided on both the door and the window so that they can be opened from a distance. This is an excellent precaution. Properly constructed, such a house as this will last for generations and require a minimum outlay for repairs. The total initial cost of the house to Mr. Eickhoff was under $100. It was built by a cement contractor.

CYANIDE OF POTASSIUM.

In the formula given for the fumigation of nursery stock it is necessary that the cyanide of potassium should be very pure. There are ordinarily two grades of cyanide put out by manufacturers, one

of which is known as "chemically pure" and the other as "commercial." Chemically pure does not always mean that the preparation will run 100 per cent cyanide of potassium. It often means that the



Eickhoff's Fumigation House Near Indianapolis.

chemical is as pure as it is possible to get it by the process employed by the manufacturer. A different process or different facilities for manufacture might result in a slightly higher or lower grade of finished product. To be reasonably good, cyanide of potassium C. P. (chemically pure) should not be lower than 95 per cent pure. The "commercial" grade makes no pretensions of purity and if it tests 50 per cent pure it will be exceptional. For the fumigation of

nursery stock it is best to use only pure chemicals, as comparatively small quantities are used and better results obtained. Using the formula which we publish in this bulletin, it is absolutely necessary to use the very best chemicals obtainable in order to produce the required volume of gas. Cyanide which tests less than 90 per cent pure is practically worthless for the purpose of fumigation, using our formula.

The following table shows the results of tests on a series of samples obtained from nurseries over the State where they were fumigating stock. The last four samples were obtained by the State drug inspectors and show that as a rule the "cyanide" which is sold by the average druggist is of the commercial grade.

Retail Dealer and Manufacturer.	*Per cent Cyanide.*
T. E. Otto, Columbus, Ind.; Roessler & Hasslacher	92.9
A. Kiefer, Indianapolis; Roessler & Hasslacher	97.6
Barge & Madden, Montpelier	53.2
F. & D. Emshwiler	48.6
F. B. Burk, Bloomfield; Roessler & Hasslacher	98.2
B. F. Buchanan, Rising Sun; Merck	100.4*
Mac Carper, Winamac (not potassium cyanide but ferro cyanide and worthless).†	
A. F. Sala, Winchester; not given	37.6
Ft. Wayne Drug Co.; not given	46.6
White Drug Co., Union City; not given	79.4
J. E. Stewart, Union City; not given	39.2

The ordinary commercial sulphuric acid will answer for all purposes of fumigation, as it is usually reasonably pure. *It must be remembered at all times that the cyanide of potassium is a very deadly poison and it must be handled with the greatest care.* It should never be left where young or ignorant people may find it and it always ought to be kept in a tight jar, or can, and be plainly labeled both with its name and the word "Poison."

FUMIGATION METHODS.

The trees should be loosely packed in the fumigation house and care should be used to see that they are as dry as possible before fumigating. If the trees are wet they are liable to be damaged by the hydrocyanic acid gas.

*Tested over 100 per cent owing to a small quantity of sodium cyanide; not an objectionable departure.

†Fumigation with this material was worthless.

The last four samples were collected by the State Drug Inspector. Tests were made in the State Food and Drug Laboratory by Mr. I. L. Miller.

Mr. Hiram McFeron, a nurseryman at Columbus, Ind., and a most successful man in the practice of fumigating, digs his trees during the day, and at once places them in the fumigating house. By night the building is nicely filled and ready for the gas treatment. This gives the trees a chance to air dry and also makes it possible to ventilate the building all night and render it perfectly safe to enter and remove the stock in the morning.

When the trees are satisfactorily placed in the house they are ready for the actual fumigation, which is accomplished as follows:

Secure a large, deep stone or glass jar and place it on the floor of the fumigating house. In it place the required quantity of acid and water and drop in the cyanide enclosed in a thin paper bag and get out at once, closing the door tightly for forty minutes. At the end of this time the door should be opened and the house allowed to ventilate for at least an hour—or better, overnight.

The quantity of chemicals to use must be calculated for each individual case owing to the difference in the size of the houses. The following formula shows the correct proportions for 100 cubic feet of space, and to find the required amount for any given room it will be necessary to first figure the cubic contents and multiply the amounts given in the formula accordingly.

We mention this especially, since we found that some of the nurserymen who received our last circular had figured for square feet, although our directions were explicit.

The following chemicals generate enough gas to fill 100 cubic feet of space in the house:

Water	4 ounces
Sulphuric Acid	2 ounces
Cyanide of Potassium C. P.	1 ounce

Place the water in a jar, then add the acid and stir. Finally add the cyanide enclosed in a thin paper bag.

Using the precautions mentioned this process of fumigation will prove effective in killing all San Jose scale and other scales and insects not in the egg state. It will not injure any dormant stock if used according to directions, but must not be used on conifers.

CAUTION.

In case any of the gas should be inhaled at any time the victim should be taken at once to the open air and given ammonia by inhalation. A bottle of ammonia should always be kept ready for such an emergency.

Mr. W. C. Reed, President of the State Horticultural Society,

Fumigation House of Harry Haas at Terre Haute.

and a prominent nurseryman of Vincennes, Ind., has prepared the following article on the fumigation of buds and scions. It will be of especial interest to nurserymen as it is based on practical fumigation experience for several years:

FUMIGATION OF BUDS AND SCIONS.

BY W. C. REED.

The young seedlings are usually free from disease and insect pests. But the bud sticks and the scions that are cut for budding and grafting are not so apt to be in healthy condition. They may be fumigated with perfect safety—even the tender rose buds and peach buds.

There must be no appearance of moisture on them at the time. When the leaves have been removed from the bud sticks they are placed loosely on the wire tray in the fumigator. If you dampen the leaves to keep them from wilting while cutting, as most nurserymen do, be sure to spread them out thinly in the sun for a few minutes, and turn them several times to be sure the moisture evaporates.

Fumigation Box.—Any box that can be made perfectly tight will do. I have fumigated all buds during the past two years in a box 3 x 3 x 3 feet in dimensions, made perfectly tight, using half-inch lumber with paper between. There is a tight-fitting door on the side, twelve inches wide, extending from the top to the bottom. Eight inches from the floor there is a wire tray or screen on which the bud sticks are placed loosely. The generator is placed beneath the screen, allowing perfect circulation of the gas.

Formula.—Cyanide of potassium (98 per cent pure) 6.75 grams. Sulphuric acid (1.83 specific gravity) 9.5 cubic centimeters. Water 15 cubic centimeters. Exposure to gas thirty minutes.

The above is about three-fourths strength. Glass beakers or measures with the centimeters marked on them can be secured from any leading drug store. Cyanide, as carried by the average druggist, will not do. The large wholesale houses carry it put up in one-pound cans guaranteed 98 per cent pure.

Weighing Cyanide.—Owing to the small amount used it must be absolutely accurate. For this purpose a pair of small balances are best. The Miner's Improved Gold Scale, used by gold miners and pearl hunters, can be bought from jewelers. Take them to your druggist and have the weights tested and reduced to grams to suit the size of your box.

Caution.—Remember all weights and measures must be accurate and the measuring should always be done the same way. It is best to hold your breath when dropping the cyanide, closing or opening the door; one breath of the gas might be fatal. The gas will discolor the edges of the leaf stalks and bud sticks where the sap is exposed but will not injure them otherwise. Dampen them and pack them away in moss as soon as you take them from the box.

Fumigation House of William McElderry at Princeton.

THE FUMIGATION OF GREENHOUSES.

There is a distinct lack of data on this subject and that which we do have access to seems to be more or less contradictory.

For years it has been the practice to use tobacco smoke in greenhouses for the extermination of plant lice on roses and carnations. Formerly a smudge of tobacco stems was used to create a dense smoke. The same result is now obtained by the use of tobacco powder, the effect on the lice being the same and the tobacco powder is, perhaps, more convenient to use. With tobacco fumigation the smoke was left in the house overnight and usually a considerable percentage of the lice were killed. There were nearly always a few of the insects left, however, and in a few weeks they were as bad as ever.

The chief advantage of the tobacco smoke lies in the fact that it is usually not injurious to foliage and flowers—though some blooms, like the crysanthemums, will not bear tobacco after the buds start to open.

The fact that tobacco is useful in combatting only the plant lice and that it is practically worthless for such forms as the mealy bug, the white fly and the thrip, renders a new fumigation system necessary.

For this purpose hydrocyanic acid gas has been employed to a certain extent, though not enough to give us absolute figures on the amount of chemicals to use, the length of exposure needed to kill insects, nor the plants most liable to be injured by the gas. In fact these matters will vary so much with the condition of the house where the fumigation is carried on that we will probably never be able to say absolutely just what is the right procedure in the use of hydrocyanic acid gas in greenhouses.

The following plants have been treated to a twenty-five minute exposure of gas generated by using 0.15 grams per cubic foot of air space and practically no damage has resulted.

UNINJURED.

Abutilon
Acacia
Alocacia
Alternanthera
Anthericum
Araucaria
Ardisia
Begonias
Caladium
Calla
Carnation
Clerodendron
Crotons
Cryptomeria
Curculigo
Daphne
Euphorbias
Ferns
Ficus elastica
Fittonia
Grasses
Grevilleas
Hedichium
Hoya
Justicia
Lavendula
Magnolia fuscata
Marantas
Mosses
Plumbago
Strobilanthus
Tradescantia (green)
Tomato
Violet—double

TENDER LEAVES INJURED.

Acalpha
Achyranthus
Agava filifera
Ageratum
Akebia
Aloysia
Alpinia nutans
Aralia
Bouganvillea
Cacti
Cestrum
Chrysanthemum
Citrus
Clematis

Coleus	Musa
Coelogyne	Nasturtium
Cuphea	Oxalis
Ficus repens	Palms
Freesia	Pandanus
Fuchsia	Primula
Genista	Roses
Geranium	Cyperus
Heliotrope	Dendrobium
Hibiscus	Dracaenas
Jasminum	English Ivy
Lantana	Salvia
Lopezia	Smilax
Mimosa	Stevia
Monstera	Streptosolon
Murraya	Violet—single

TOTALLY KILLED.

Pellea	Tradescantia bicolor

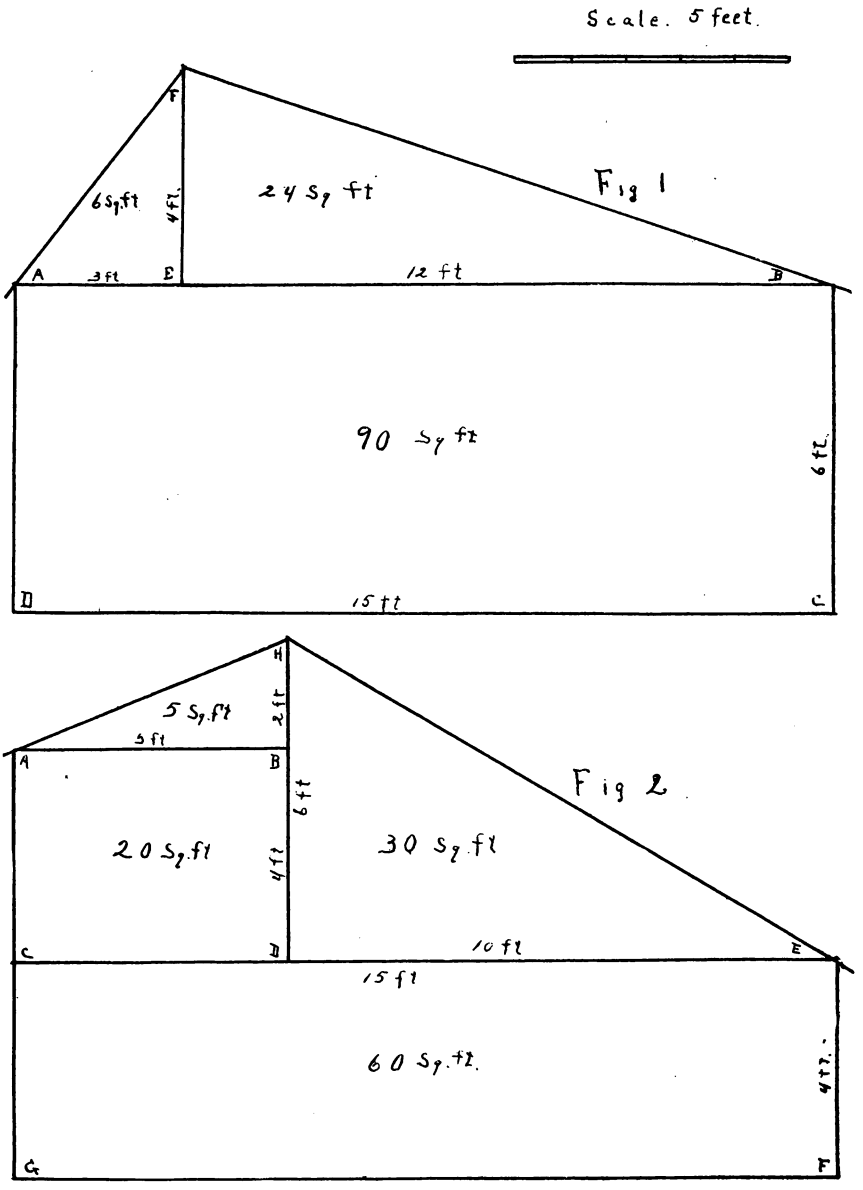
This list is taken for the most part from a report by George E. Butz in the Report of the Pennsylvania State College for 1900.

The effects on insects is much more satisfactory than with tobacco smoke. Plant lice are invariably completely exterminated, often not recurring for many months. Scale insects are killed except when in the egg state. Masses of mealy bugs are not always destroyed, owing to the fact that the gas does not penetrate to the individuals in the interior of the mass. Sowbugs and snails are usually killed by one application of the gas.

METHOD OF FUMIGATING.

To begin with no greenhouse should be fumigated with hydrocyanic acid gas unless the ventilators can be readily opened from the outside. If this cannot be arranged it is best not to attempt to fumigate at all, as a house cannot be safely entered until the ventilators have been open for at least an hour.

Providing the house is adapted to fumigation with hydrocyanic acid gas the first thing to do is to determine the cubic contents of the house in order that the proper amount of chemicals to be used may be calculated. First figure the area of a cross-section of the house in square feet and multiply that result by the length of the house. This will necessitate careful figuring to determine the cross-section area of an irregular house.



To find the cross-section area of an irregular shaped greenhouse, first draw a rough outline of a section of the house, and measure carefully the different dimensions as indicated above. Then mark off the areas which will form perfect rectangles as indicated in the two rectangles ABCD and the rectangle CEFG. The area of these spaces can be easily found by simple multiplication. All of the triangles are right angled triangles, and to find the area of such a figure you multiply the two straight sides and divide the product by two. Thus in figure one the triangle FEB is four feet on one side and twelve feet on the other side. Following the method indicated we find that the area of the space is 24 square feet. When the different spaces have been calculated, the results are to be added together to get the total area of the cross-section.

The accompanying diagram will assist in indicating the method of calculating the area of the triangles. After finding the cubic contents of the house, multiply the number of cubic feet by 0.15 and the result will be the number of grams of cyanide to use for the entire house. For each part of cyanide use two parts of sulphuric acid and four parts of water. Place the water in an earthenware jar, add the acid and suspend the cyanide enclosed in a cloth bag just above the jar so that it can be lowered into the acid by the workman at the door. The generation of gas is very rapid and the cyanide should never be placed in the jar by hand as the fumes may overtake the operator before he reaches the door. In a long house it would be better to use several jars and to divide the quantity of chemicals so that all of the gas would not be liberated at one point. This will allow of a more even distribution of the fumes over the house.

The time of fumigation should always be at night, as the gas is less liable to be injurious to foliage if used in the dark. This will also allow of a thorough airing of the house before morning. It is best not to have the benches too wet and the house should not be sprinkled for several hours before the treatment is applied, as any water on the plants will absorb some of the gas and retain the poison for some time. This often causes damage not otherwise explainable.

During the period of exposure the house should remain closed as tightly as possible. If the roof is at all loose it will be a good plan to sprinkle it from the outside before fumigating. The water will close many of the small cracks that could not otherwise be closed.

FUMIGATION OF MILLS.

Flour mills, elevators, and other places where grain is stored are often troubled with insects and rodents and the hydrocyanic acid gas is a very effective treatment for such pests. The cubic contents of the building should be roughly estimated and the same chemicals used as are recommended for the fumigation of nursery stock. This kind of fumigation does not involve possible damage to the stock, so that the gas can be left in the building as long as desired—over night perhaps. The building should not be entered for several hours after the doors have been opened, however, as there are liable to be "pockets" of the gas left in quiet corners of the building. The greatest danger attaches to fumigation of this character owing to the fact that large quantities of chemicals are used and an immense amount of gas is generated.

At one mill in the southern part of the State a careless workman set off a charge of chemicals on one of the lower floors and then went upstairs to start another lot. The gas being exceedingly light, quickly reached the upper floor and the man lost his life. An accident of this sort deserves no sympathy, as it is the result of pure carelessness and could have been avoided by a little intelligent attention to directions. In all of our publications relative to fumigation we have been particular to mention the exceedingly poisonous character of the gas and if any trouble comes from handling it the victim is alone to blame.

CARBON BISULPHIDE.

This is a clear, slightly yellowish liquid which is sometimes used to kill or repel weevil in grain bins. It is very volatile and very inflammable and should never be used near a light. It can best be used in grain bins which can be tightly closed so as to retain the effects as long as possible. The method of use is to place several ounces in a flat dish, place it in the bin and allow it to evaporate. While it has a bad odor it is not particularly dangerous to handle—if you keep it away from the fire.

FUMIGATION FOR HOUSEHOLD PESTS.

In most of the large cities are to be found men who make a business of exterminating insect and rodent pests in boarding houses and other buildings. These individuals use the same hydrocyanic acid gas that is used in the fumigation of nursery stock.

The remarks relative to the fumigation of greenhouses and mills would apply to the fumigation of dwellings except that I would repeat and emphasize the caution relative to the use of the gas.

Bedbugs, lice, moths, roaches, carpet beetles—the whole list of household insects—as well as rats and mice will be exterminated with a good fumigation with this gas. But it should never be employed without first making a careful study of the conditions of the building and arranging some safe way of ventilating the building after exposure to the gas.

Any special problems relative to fumigation will have prompt attention if sent to this office.

Egg Case of Common Garden Spider.

INSECTS.

In order to properly understand the problems connected with insect control, it is necessary that we should know something about the life history of the various forms with which we have to deal. Such a knowledge is important in that it enables us to recognize a noxious insect in any of its widely varying stages and to more easily study its habits and discover, if possible, the most strategic time for combating it.

Cocoon of Cecropia Moth Cut Open to Show the Pupa.

In general there are two distinct types of life cycles or life histories. In the first type, which is by far the most common, the young insect hatches from an egg laid by the adult. It emerges in the form of a grub or caterpillar and in this stage usually does most of the feeding. When it has reached its full size it changes into the resting stage known as the pupa. After a resting stage in the pupa the insect again changes, this time emerging as a mature or adult insect. These varying changes are commonly represented by

the expression "metamorphosis"; which is a word simply meaning "change." An insect which undergoes all of the changes indicated above is said to possess a "complete metamorphosis," to distinguish it from insects like the grasshopper which possess what is called an "incomplete metamorphosis." In the latter group the young insect

Cecropia Moth, Showing Folded Condition of Wings Just After Emerging from Cocoon.

hatches from the egg as a grasshopper, differing from the adult principally in size. After it begins to feed and grow it soon sheds its outer shell, or moults. With each moulting there is an increase of size until the full growth is attained.

Roughly, insects may be divided into two great classes according to whether they undergo a complete or an incomplete metamorphosis.

Adult of Cecropia Moth.

As an illustration of the complete metamorphosis we will take the case of the common Cecropia moth, which is representative of all the moths and butterflies. The adult, which is probably the largest insect in North America, lays its small cream colored eggs on the leaves of a great variety of trees and plants. From these eggs hatch small spiny black worms or caterpillars which immediately begin to feed on the nearest foliage. With the growth of the caterpillar many changes of the skin occur to accommodate the increasing size of the insect. This is distinctly the feeding stage in the life history of the insect and it is now that it does its greatest damage.

This is true of nearly all of the insects which damage by chewing—that their injurious work is done in the caterpillar (larval) stage. When the larva attains its growth it begins to spin for itself a cocoon in which to pass the next stage of its life history. This is the resting period, during which the insect is called a pupa. This dormant period may last only a short time or it may continue all winter, but finally the adult insect emerges from the cocoon and the life cycle is complete. This series of changes constitutes what is known as a complete metamorphosis. We may have more or less of a variation in the succession of changes—for instance, not all moths and no true butterflies ever make cocoons, but remain in the resting stage either in the ground or attached to trees or fences.

Insects may further be divided into two great groups according to their habits of feeding. It is the feeding habit which gives us the basis for the economic classification of insects as chewing or sucking individuals; each class requiring distinctly different control measures, though the same measure is usually applicable to all the members of the class.

Insects in general may be considered as those segmented animals possessing a horn-like external skeleton, moving about by means of six jointed legs and never having more than two pairs of wings. In most insects the segments can easily be separated into three more or less distinct groups. These groups are the head, thorax and abdomen, and consist of one, three and nine segments, respectively. The legs are invariably borne on the thoracic segments—one pair to a segment. The wings, when two pairs in number, are borne on the second and third thoracic segments. When only one pair is present it occurs on the second or middle segment—never on the first. These distinctions easily separate the insects from the crustaceans and spiders, all of which have four pairs of jointed legs and lack the articulated head.

The Cocoon and Pupa of the Common Spice Bush Leaf Roller.

Immature insects often present variations of structure which are interesting, though often misleading. The true caterpillars (the larva of moths and butterflies) possess, in addition to their three pairs of jointed legs, five pairs of leglike structures attached to various segments of the abdomen. These pseudopodia (false feet) disappear when the insect changes to the adult. The larva of the saw flies may be differentiated from those of the moths and butterflies by the fact that the pseudopodia number six pair instead of five.

Some of these caterpillars resemble the true segmented *worms,* but may always be told from them by the fact that worms never bear any structures which could be mistaken for the jointed legs of the insect larva nor do they possess the articulated head of the latter.

Since this report has to do with the economic relations of insects more than with their structure, all established systems of classification are disregarded in the following arrangement of orders. Nor are all recognized orders of insects represented, owing to their low economic importance.

HEMIPTERA.

This order of insects includes all of the forms which obtain their food by piercing or sucking. The term Hemiptera means, literally, "half-winged," owing to the fact that some members of the group have the basal portion of the forewings thickened so as to appear as only half of what it might normally be expected to be. The mouthparts are adapted for sucking. The metamorphic changes are incomplete. It is only to members of this order that the term "bug" can properly be applied.

The forms having the forewings of a uniform texture are sometimes grouped together under the term Homoptera.

ORTHOPTERA. (Grasshoppers and their kin.)

In this order the forewings (if any wings are present) are long, narrow and slightly thickened, being but little used in flight. The mouthparts are fitted for chewing and the metamorphosis is incomplete.

LEPIDOPTERA. (Butterflies and Moths.)

These forms have the body and wings covered with scales. In the adult the mouthparts are fitted for sucking but not for piercing. The larva will have chewing mouths. Transformations are complete.

HYMENOPTERA. (Bees and their kin. Sawflies.)

In these insects the wings, of which there are two pairs, are transparent. The mouthparts are fitted for chewing, though in some cases the tongue is developed for lapping. The metamorphosis is complete.

COLEOPTERA. (Beetles.)

The forewings are not used in flight and are greatly thickened, serving as covers for the second pair of wings. Mouthparts are fitted for chewing. The metamorphosis is complete.

DIPTERA. (Flies.)

The flies possess only a single pair of transparent wings. The mouthparts vary considerably in structure but in each case are fitted for sucking. The transformations are complete.

Sucking Insects.

The sucking insects are those that have their mouthparts so developed as to form a tube or probocis, as it is called. They obtain their food by inserting this tube through the skin of the plant (or animal) on which they feed. As it is not possible to poison the plant juices which form the food of this class of insects we must apply insecticides which will kill by direct contact.

There are a number of such forms of contact poisons and they will be dealt with in detail in a separate chapter.

The scale insects, the plant lice, and the true bugs are examples of the sucking insects. It is true that the adults of the butterflies or moths have their mouths modified for sucking the juice of flowers, but it is in the larval stage that they do their real damage, as chewing insects, and they will be considered under that class.

SCALE INSECTS.

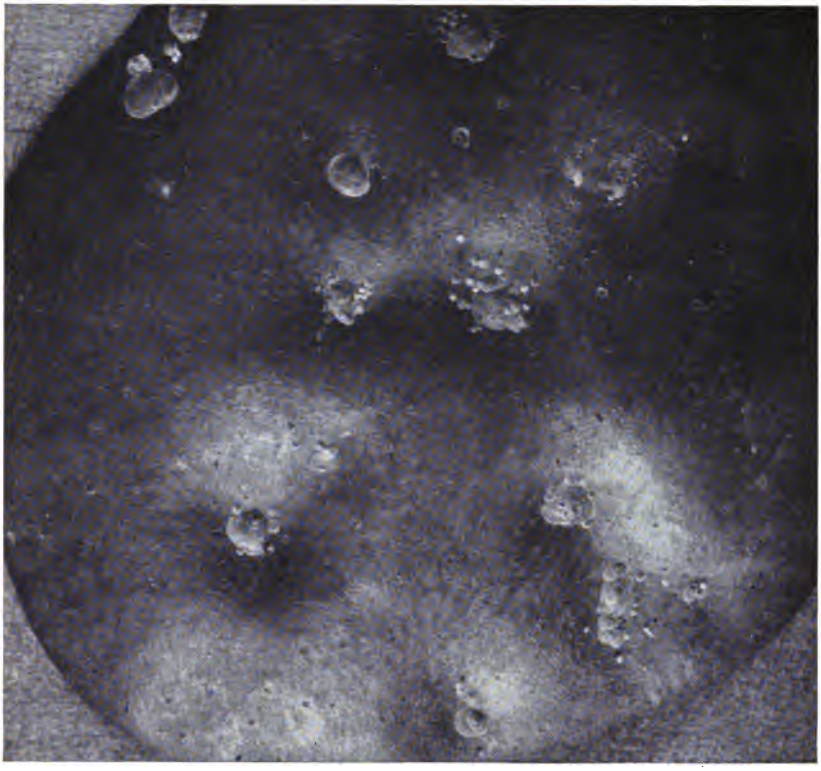
No other economic insects have attracted more attention from the general public than the large and destructive class known as the scale insects. They are especially dangerous owing to their small size, inconspicuous character, and the rapidity with which they increase in numbers. It is commonly the case that a whole tree will be crusted over and killed by the scales before their presence is noticed by the average observer, and a few scattered scales on a tree will be detected only by the trained eye of the expert.

The scale insects have many characteristics in common, chief of which are their habits of feeding by sucking the plant juices and the fact that the body proper is covered by a plate or scale.

SAN JOSE SCALE.

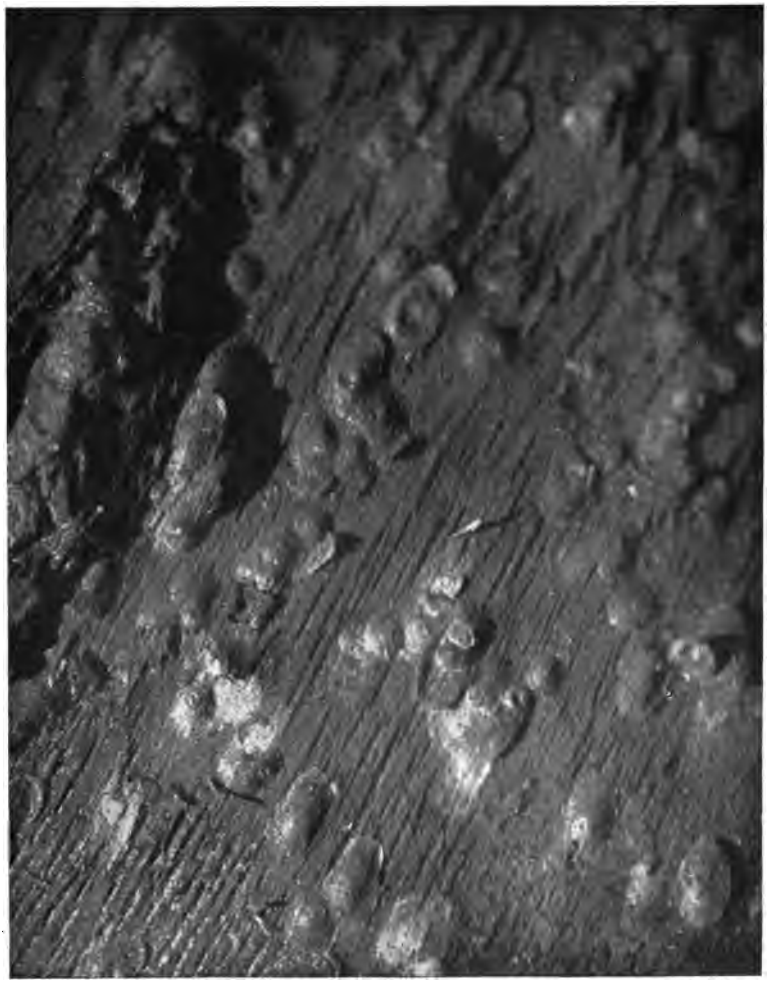
(Aspidiotus pernicious Com.)

The San Jose scale, as it is called, was first noticed and described at the town of San Jose (pronounced San Hozay), California, about thirty-five years ago. It is a native of Northern China and in that country is controlled by a lady bug which feeds on it. There have been attempts at the introduction of this parasite into the United States, but at the present time there is no record of any of the lady



San Jose Scale on Fruit—Slightly Enlarged.

San Jose Scale, Showing Adult Females and Colonies of Young Scales Surrounding Them. Enlarged About Twelve Diameters.



San Jose Scale (Male) Enlarged About Ten Diameters. Notice the Elongated Appearance of the Male Scales.

Male San Jose Scale Along Main Rib of a Leaf. Enlarged About Ten Diameters.

Surface from Peach Tree Crusted Over Completely with San Jose Scale. Enlarged Ten Diameters.

Anal Segment of San Jose Scale Under Microscope, Highly Magnified.

bugs being established. At least two species of native lady bugs are known to destroy this scale, but as a rule they are not numerous enough to do any material good and no great results can be expected from them.

Forbes Scale on Cherry Bark. Notice that the Scales Are More Numerous Along the Crevices in the Bark. Enlarged Ten Diameters.

During the past summer the Twice Stabbed lady bug (Chilocorus bivulnerus) has appeared in unusual numbers in many places in the State and for a time it looked as though certain infested districts would be freed of the scale by this insect. As the summer advanced, however, the beetles decreased in numbers and the scale soon recovered its former ascendency.

It is important that the student of economic entomology should learn to recognize the San Jose scale in any of its several stages.

Life History.—The San Jose scale begins life as a minute, orange-yellow insect, crawling freely about over the trunks and limbs of trees whereupon its parent is attached. It is in this stage that the pest is most generally distributed by birds. It will crawl on the feet and legs of the birds and will be carried often great distances before it crawls off onto another tree.

Putnam Scale in Axil of a Bud. Notice that this scale differs from the San Jose Scale in that the lines around the center are not concentric.

This period of activity continues, at most for a day or two, when the young scale settles down and begins to secrete the plate or scale proper, which cements it firmly to the bark. It grows during the summer, feeding on the plant juices, which it draws through the bark with its proboscis, and in the early fall the eggs are fertilized in the body of the females by the winged male.

At the approach of winter the insect, still containing the half-grown young, ceases feeding and becomes dormant, to resume feeding at the first approach of warm weather. Early in the spring the young emerge from the body of the parent, thus completing the life cycle.

In Indiana the San Jose scale produces several broods each sea-

son and we can find the active yellow larva at almost any time of the summer. As winter approaches many of the scales are killed by the cold and only the well-established individuals live till spring. The male scales never live through the winter at the latitude of Indianapolis.

Adult Scale.—The adult scale appears as a small rounded plate, gray in color, the center darker and elevated, the whole insect not more than one sixteenth of an inch in diameter. On a badly infested tree the scales will be so close together as to completely hide the bark, giving the branch an unhealthy, scurfy look.

It should be noticed that the form of the male and the female scale plate is very different, that of the male being elongated to accommodate the wings. The San Jose scale is the most difficult of all the scales to control, for two reasons. It, in the first place, multiplies very rapidly and is relatively free from parasitic enemies. In the northern part of Indiana a large percentage of the scales are killed by freezing every winter. In the southern part of the State only the males are winter killed, and in some seasons even they may withstand the effects of the cold. This fact renders the scale conditions in the south worse than in the north—though they are bad enough everywhere.

The general question of the control of the San Jose scale and other scale insects will be taken up elsewhere in this report.

COTTONY MAPLE SCALE.

(Pulvinaria innumerabilis Rathvon.)

During the past few years the Cottony Maple scale has killed many trees in Indiana. It has not been confined to maples entirely, for trees of several other genera have been attacked and killed. Little or no attention has been paid to it in spite of its deadly character.

Life History.—After hibernating on the twigs of the trees all winter the female lays large quantities of eggs in May and June. It is at this season that the scale is most conspicuous, clinging to the under side of the twig and surrounded at one end with great masses of cottony padding, which is developed from the body simultaneously with the eggs. This cottony substance is persistent on the branches through the summer and until worn off by the wind and rain.

Cottony Maple Scale. Condition in June. Notice that the Scales are all on the under side of the twig.

The eggs hatch in a short time and the young at once migrate to the leaves where they attach themselves in rows along the veins and begin feeding. They grow rapidly and as summer advances

Cottony Maple Scale—Winter Condition. These Scales were removed from the twig to which they were attached and cemented to a piece of white paper in order that they might be more readily photographed. Enlarged about ten diameters.

the males and females are differentiated, the males developing wings. At the approach of fall the fertilized females attach themselves to the under sides of the twigs, where they remain all winter. The male dies at the end of the summer.

Cottony Maple Scale on Under Side of Maple Leaf in Mid-Summer. Notice that the Scales are arranged along the veins of the leaf. Magnified ten diameters.

Soft Maple Tree partly killed by the Cottony Maple Scale. This tree is characteristic of trees in infested districts.

Treatment.—Winter spraying with the lime-sulphur-salt wash is the best means of controlling the Cottony Maple scale.

There are several parasites that destroy the Cottony Maple scale and in some localities where it was formerly very bad I find that it is now practically controlled.

On affected trees the leaves fall persistently throughout the season, often ending with the death of the tree. These leaves should be carefully raked up and burned as they may become a source of infection for some other tree.

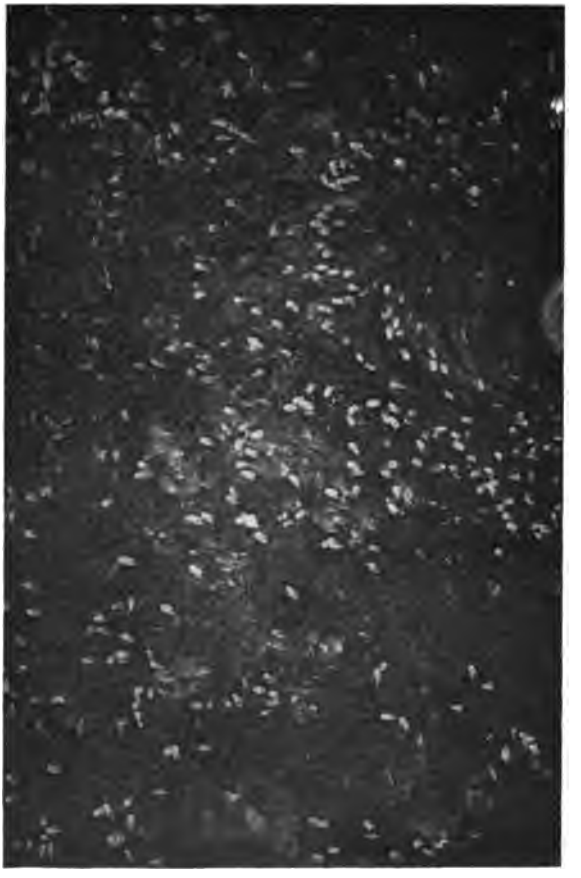
During the summer of 1908 a small tree at the north of the State House yard became badly infested with the Cottony Maple scale and an attempt was made to exterminate it at the time. A preparation known as Horricum was first used but had no other effect than to damage the foliage to a certain extent. Later the tree was sprayed twice with one of the proprietary miscible oils (Scalecide) and the majority of the scales were killed. The oil was used in the proportion of one part to thirty-five and was thoroughly applied. The chief difficulty was in reaching the young scales that had not yet emerged from the cottony padding. The oil was effective at the high dilution point owing to the fact that the scales were still young and tender.

Female Scurfy Scale on Apple Twig. Magnified three diameters.

SCURFY SCALE.

(Chionaspis furfurus Fitch.)

The members of the genus Chionaspis are rather conspicuous scales and are easily recognized. They are nearly white in color and of an oval shape. The males and females are of very different appearance, as represented in the accompanying cut. The Scurfy scale passes the winter in the egg state. It is most common on the apple and pear.

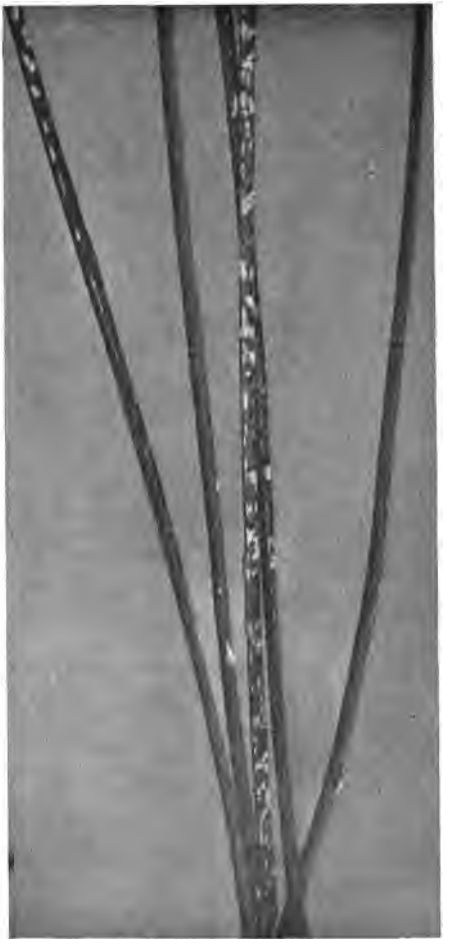


Male Scurfy Scale, showing badly infested surface of an Apple Tree. Magnified about five diameters on male scales. Notice that the males differ distinctly from the females, both in size and shape.

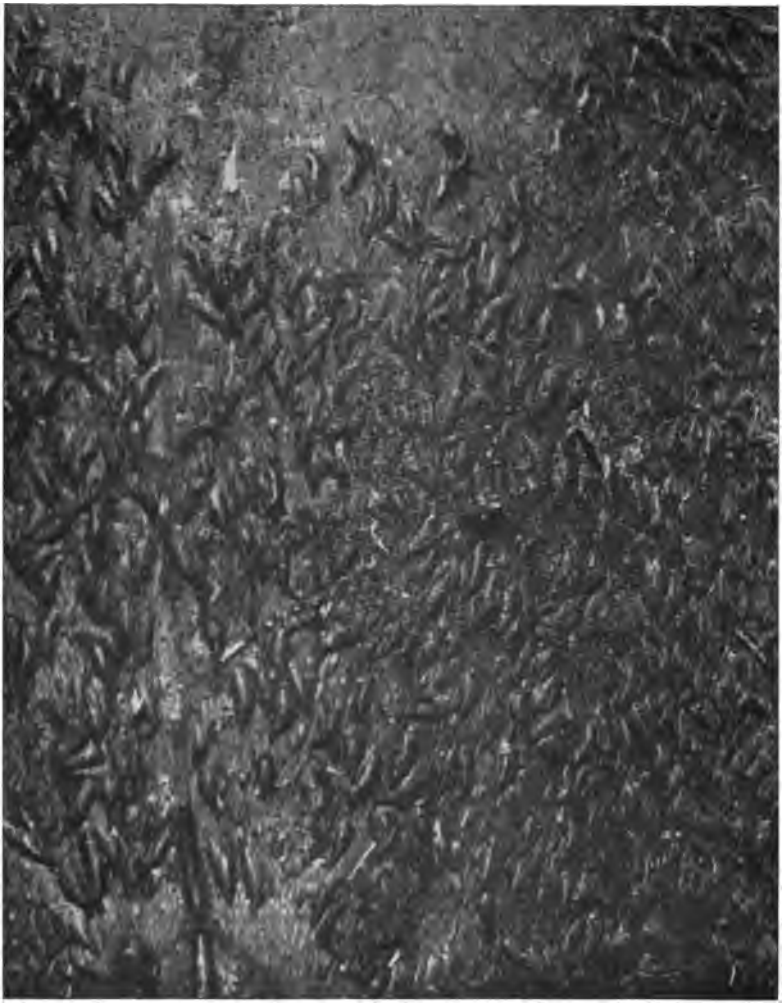
PINE SCALE.

(Chionaspis pinifolia.)

The Pine scale resembles the Scurfy scale very closely but attacks only conifers, sometimes doing considerable damage. It attaches itself to the leaves, where it becomes very conspicuous owing to its light color against the dark green background of the leaf.



Pine Scale. This Scale is closely related to the Scurfy Scale and resembles it, except in size, being smaller.



Oyster Shell Scale, magnified about three diameters.

Oyster Shell Scale on Orange Fruit. Magnified about ten diameters. This is one of the means of the distribution of scale insects.

OYSTER SHELL SCALE.

(Mytilaspis pomorum.)

There are several species of the Oyster Shell scale in this country, but they have many common characteristics and are much alike in their life history. With us the Oyster Shell scale produces but one brood of young each year. The winter is passed in the egg state and for that reason it is a very hard scale to deal with. The scale plate of the adult insect acts as a storage place for the eggs and in winter the entire cavity is filled with them.

While this scale produces but one brood each year they often are so numerous as to become a menace to several kinds of trees. In the north the apple and the poplar are the most often infested. In the citrus fruit districts considerable trouble is often experienced with a similar form which we often see on oranges and lemons which have been shipped north. The treatment is similar to that of the San Jose scale. Whale oil soap may also be used on the young scales as soon as they hatch in the spring, as at that time they are easily killed. The fact that but one brood is produced makes this spring treatment practical when it could not be used on the San Jose or other scales which have several broods each season.

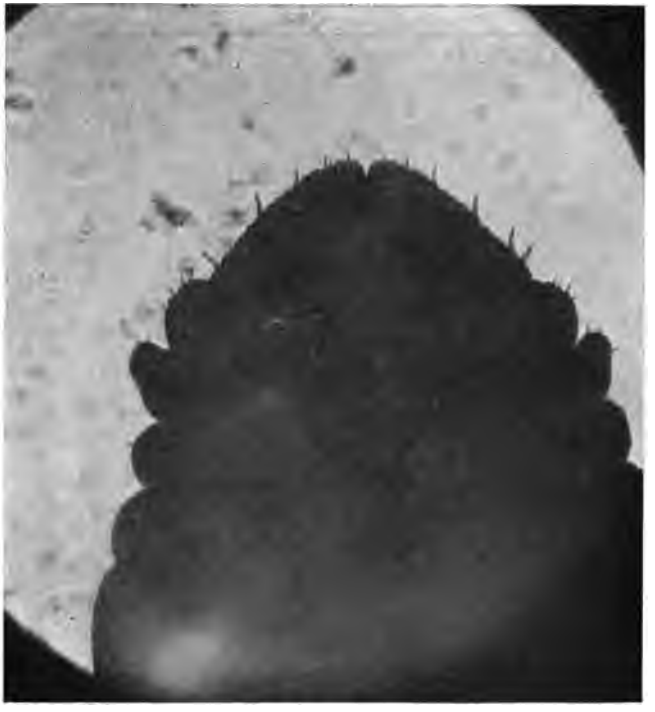
THE ROSE SCALE.

(Diaspis Rosae.)

This scale is confined almost exclusively to the rose, the blackberry, and the raspberry and often does considerable damage in the small fruit districts. The scale plates are white in color and are one-sixteenth of an inch or more in diameter. In the winter they fall off readily and expose the bright orange-red insect. Any of the sprays recommended for the San Jose scale will prove effective in controlling the Rose scale. All badly infested or dead canes should be cut out and burned in the winter when the scales show very conspicuously.

This scale passes the season in the adult stage and is readily killed by fumigation. It is probable that in the treatment of infested nursery stock it will be entirely practical to substitute the practice of dipping trimmed canes in place of fumigating them, as the scale plates offer much less resistence to scalecides than do the members of the Aspidiotus group.

Rose Scale, enlarged about ten diameters.



Anal segment of Rose Scale, highly magnified.

POPLAR SCALE.

(Eulecanium Tulipiferae.)

The so-called Yellow Poplar scale does not belong to the true scale insects, but is a member of a closely related family, the Lecaniums. It occurs, so far as we have observed, only on the Yellow Poplar or Tulip tree, and as yet it is not very common in Indiana. In the two stations from which it was reported, Valley Mills and Darlington, it is said to be doing considerable damage.

This is one of the insects that, as a rule, is controlled by native parasites, though often marked damage is done before the parasites are able to secure the upper hand. The remedies suggested for the San Jose scale will prove effective against this "scale."

Yellow Poplar Scale. Slightly more than natural size.

Yellow Poplar Scales, showing adult and young scales on same twig. Enlarged five diameters.

Yellow Poplar Scale, showing surface crusted with young scales. Enlarged twelve diameters.

MEALY BUGS.

The Mealy Bugs owe their name to the peculiar soft, powdery appearance which they present, due to the exudation of a sort of wax over the surface of the body.

The leaf of the Coleus infested with the common Mealy Bug.

They are more typically tropical insects and as a rule do damage in the north principally in greenhouses or on plants which are wintered over in greenhouses.

Mealy Bugs are readily destroyed by any of the milder contact insecticides.

A tropical form of the Mealy Bug furnishes the coloring matter known as cochineal, which is used in coloring many food products.

Section of Leaf of Coleus Magnified to show structure of Mealy Bug.

THE TRUE BUGS.

Of the so-called "True Bugs" the common squash bug can be taken as a typical example. It is brownish-gray in color, about an inch long, and possesses a characteristic offensive odor.

The insect feeds on the foliage of melons and other cucurbi-

taceae and if neglected it often causes great damage. The eggs are laid in the spring on the young leaves of the melon vines. They are of a yellowish-brown color and are so conspicuous as to render their collection by hand an easy matter.

The young are full grown by midsummer and lay eggs for a second brood. Often many individuals of this second brood are

In the Winter many of the True Bugs are to be found sheltered under the loose bark of trees.

destroyed by frost, but enough adults survive to carry the race over the winter. The adult bugs pass the winter in sheltered places of all sorts and but little can be done to destroy them.

The best means of control of this insect is to gather the egg-infested leaves in early spring. At the same time many egg-laying adults can be easily captured and destroyed. In melon fields it is

always well to plough the vines under as soon as they are through bearing. This not only destroys many of the young but removes hibernating places for the adults.

THE CHINCH BUGS.

(Blissus leucopterus.)

In his report on the "Insect Injuries to Corn," Professor Forbes says of the Chinch Bug that it is "on the whole the most destructive to corn of all the insect species to whose attack that crop is subject."

The insect is less than one-fifth of an inch in length, black in color and has conspicuous white wing covers. The young differ from the adults in size, in the lack of wings and in color, varying from light red to dark brown.

The eggs are laid in spring about the base and on the roots of a large number of plants of the grass and sedge families, by the adult insects which have passed the winter full grown. Often these eggs are laid on the young wheat, and as the insects are usually not full grown by the time the wheat is harvested they are forced to migrate on foot to fields of oats, corn, or other late ripening crops. During these migrations a great work of control can be accomplished by the use of trenches dug about the threatened field. The trench should be made in thoroughly broken ground and its sides must be made sloping enough that the soil can be thoroughly pulverized to prevent the insects crawling out after they once fall in.

When the weather is not dry enough to prevent the use of such a dust trench it will be advisable to try sprinkling a belt of coal tar around the field. To maintain effectiveness the tar must be repeatedly renewed.

Should the insects succeed in migrating to a new field they will congregate in vast numbers on the first green plants they come to. At this time they can be sprayed with any powerful contact insecticide. Pure coal oil would be excellent. It would, of course, kill the young plants, but the bugs would not only do that but would then proceed to finish the rest of the field.

The chinch bug is always more common after a succession of "dry" years. A single wet season will sometimes result in almost complete extinction of this insect from a badly infested district.

It should not be overlooked that certain birds are an important factor in the control of this insect. The quail and the meadow lark

are both fond of the chinch bug and the former does an immense amount of good in destroying the hibernating adults in the winter. So great is the work of the quail along this one line that no farmer should kill, or permit the birds to be killed by hunters. Personally I know that the bob white furnishes excellent shooting, but owing to an appreciation of its high economic value I have, in recent years, almost entirely given up hunting it.

FALSE CHINCH BUGS.

(Nysius angustatus.)

This insect is often mistaken for the true chinch bug but may be readily recognized by its uniform grayish color, sometimes marked with black speeks.

The life history and habits of the insect are similar to the true chinch bug and the same measures of control will apply whenever it becomes troublesome.

HARLEQUIN BUGS.

(Murgantia histrionica.)

This insect is occasionally a serious pest to cabbage growers, especially in the southern counties. In some places during the past dry season it has done marked damage and one cabbage patch which I saw was practically ruined by its work.

The Harlequin Cabbage Bug. One and one-half its natural size.

These bright colored bugs winter in the adult stage and in early spring lay their eggs on the young plants. The young hatch and mature in a few weeks time, producing several generations in a sea-

son. This insect will feed on any member of the mustard family, but is particularly fond of the common garden mustard. This fact suggests the use of mustard as a trap crop. It should be planted between the rows of cabbage and when the bugs congregate upon it they can be sprayed with pure coal oil.

BEDBUGS.

(Acanthia lectularia.)

Belonging to the true bugs we have this form parasitic on man. This insect is now much less common than formerly, owing to a better understanding of the laws of cleanliness and to better housekeeping. In a wide experience in Indiana hotels I have found bedbugs in only one place in the State.

When a house becomes infested with this repulsive insect, specimens can be found in cracks in the floor; around the woodwork; between the joints of the bed frame—wherever there is a slit wide enough to accommodate its exceedingly flat body.

It is no disgrace to a housekeeper to get this insect in the house, but it is a disgrace not to get it out.

Often the bugs will emigrate from an abandoned house and go to take up their abode with the neighbors; sometimes the insects are "sent home in the wash" by the none too careful washerwoman; they may even be purchased at a first-class store carefully wrapped up in a valuable piece of drygoods. But to disregard the method of their coming, it is safe to say that so long as their food supply holds out, they will not leave voluntarily.

An infested house can be cleaned of bedbugs by a liberal use of gasoline in all the cracks and crevices that could possibly harbor any of the insects. The application must be repeated, however, as gasoline is not always effective in destroying the vitality of the eggs.

LEAF HOPPERS.

(Jassidae.)

These small insects, which move about like grasshoppers and feed like true bugs, are often injurious in vineyards. On neglected vines they sometimes occur in great numbers, and when disturbed jump or fly with a quick, nervous motion. They feed by inserting their proboscis through the epidermis and sucking out the plant juices. The injured leaf turns brown—first in spots and then

altogether. Some damage is also produced by the females laying eggs within the leaf tissue.

For the most part these insects pass the winter in the adult stage under the bark of trees, in dead leaves on the ground, or in any sheltered nook that may present itself.

One obvious means of control is to remove the dead leaves from under the vines and to keep the vineyard thoroughly clean.

This cleaning work can be done in the winter time and will also assist in preventing other grape troubles due to the presence of fungi. This, however, is treated elsewhere.

During the summer months not much can be done to combat the leaf hoppers. If they become very numerous a mild contact insecticide can be used, taking care to have the vines shaken vigorously while the spray is applied. In this way many insects will be hit while they are in the air. In my own experience I have used a ten per cent coal oil emulsion for this purpose with fairly good results.

In Professor Forbes' report for 1905 he credits the leaf hopper with being injurious to growing corn. In this State I have never seen them in any field crop in sufficient numbers to cause noticeable damage.

CICADAS.

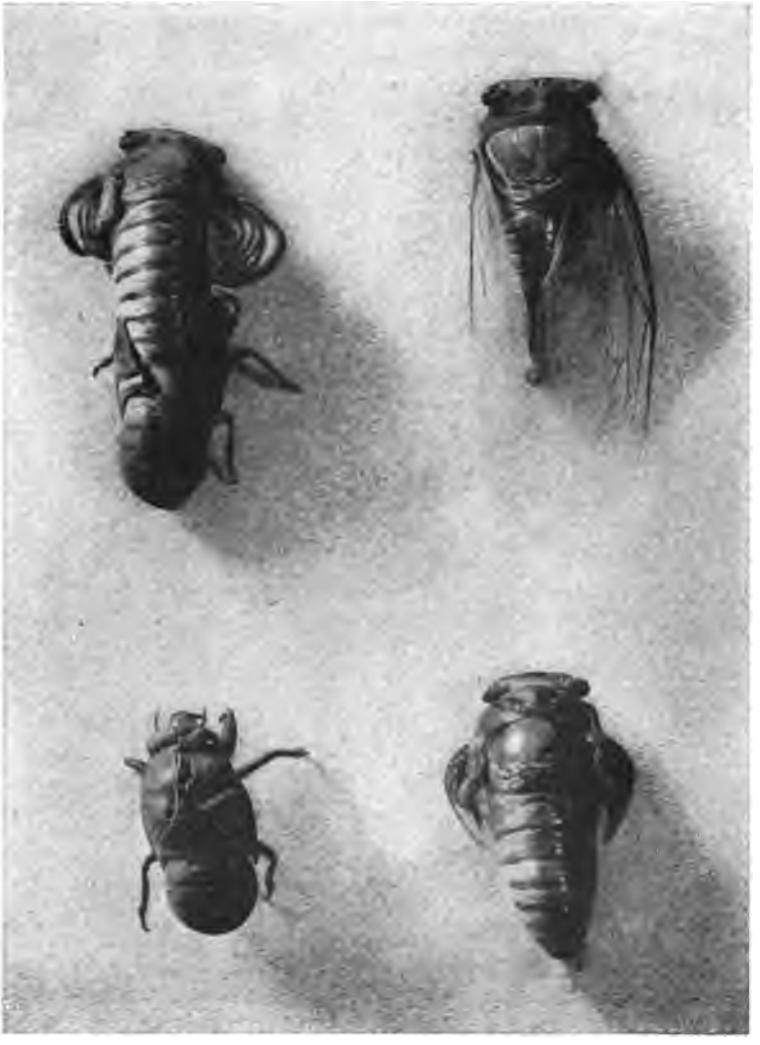
The cicadas or harvest flies, often incorrectly called "locusts," are the largest of our sucking insects. There are two species that are found in Indiana—one being known as the two-year cicada and the other as the seventeen-year cicada.

They are interesting from the point of their curious life history. The eggs are laid in the twigs of trees—the young hatch, emerge and fall to the ground and live in the soil, sucking the juices from the roots of various plants until they reach their maturity. In the case of the common harvest fly this process takes two years. With the seventeen-year locust, however, a much longer period is passed in growing from the egg to the adult. In the United States there are twenty-two different broods of the seventeen-year locust and some of these broods overlap, so that we have the appearance of the insect at more frequent intervals than would be indicated by its normal life history. There are probably three different broods occurring in Indiana. But by far the largest and most important of these is what is known to entomologists as "brood twenty-two." It occurs on Long Island, New York, New Jersey, parts of Pennsylvania, Delaware, Maryland, District of Columbia, Virginia, West

Virginia, North Carolina, Tennessee, Georgia, Ohio, Kentucky, Indiana, Illinois, Michigan, and parts of Wisconsin. This brood appeared in 1902 and will appear again in 1919. The locusts make their appearance in early summer in vast numbers and usually in rather definite colonies. As a rule the colonies seldom appear far

The Seventeen-Year Cicada recently emerged from the ground and before changing to the adult condition.

from a wooded district. Where they do it will usually be found that at the time of their last appearance the district had been covered with forest that had been removed in the meantime. These insects are of low economic importance—their only injuries consisting of egg deposits made in the twigs of trees. These punctures cause the branch to ultimately fall off and no permanent injury results. The two-year locust usually does not occur in sufficient numbers to attract any attention from an economic standpoint.



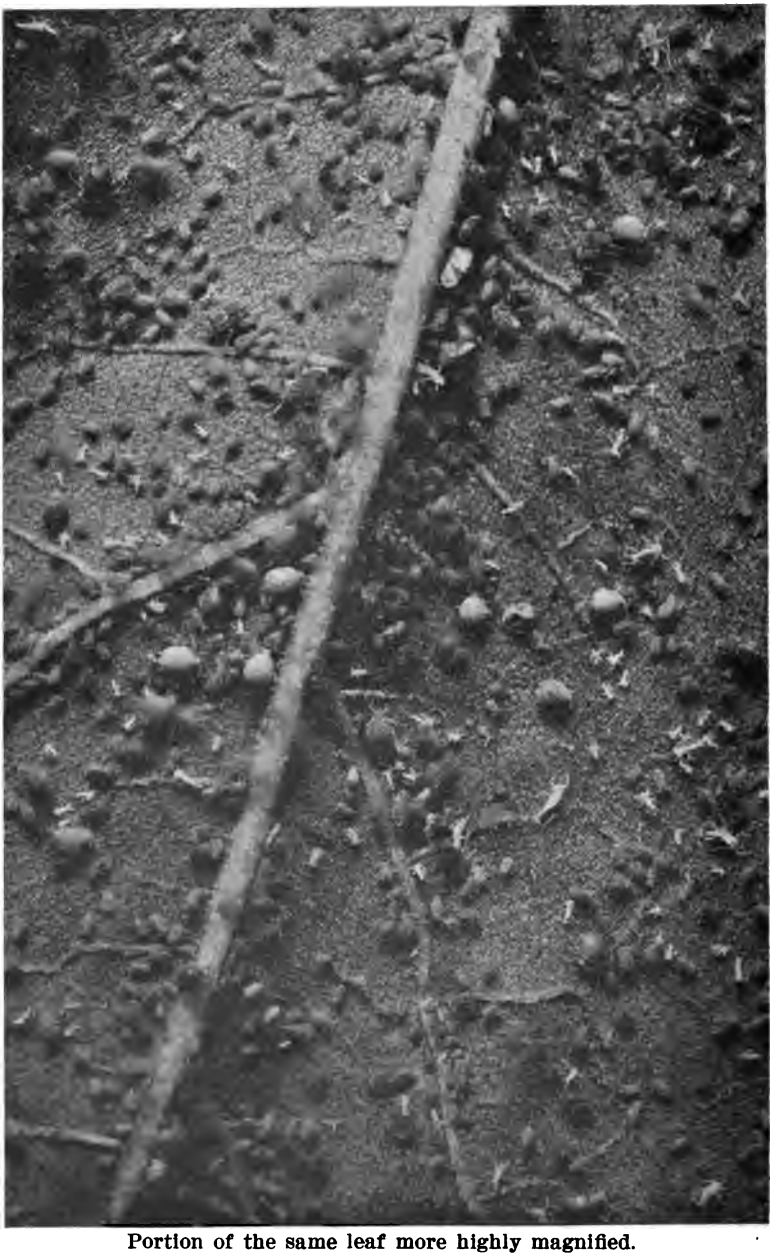
Series showing the transformation of the Two-Year-Cicada from the last larval stage to the adult.

THE PLANT LICE.

(Aphids.)

The plant lice are so widely distributed, so destructive to vegetation and so difficult to control that they present some of the most interesting problems which the economic entomologist is called upon

Sunflower Leaf covered with typical Plant Lice. Natural size.



Portion of the same leaf more highly magnified.

Portion of sunflower leaf showing Plant Lice magnified about ten diameters. Notice the varying size of the Lice, from the large adult females to the newly hatched young. The small, shapeless white objects are cast larvae skins which the young have thrown off. At least three of the adult lice are parasitized. They are shown in the picture as being much lighter in color.

to solve. Aphids in general are so well known that it is not necessary to enter into a detailed description of them at this time. However, they possess some interesting relations with the other insects which should be given especial attention.

Common Field Ants in attendance on the Plant Louse. Magnified about four diameters.

All of the plant lice excrete a peculiar sticky substance known as "honey dew." It is a favorite food with many of the other insects and the ants especially are very fond of this peculiar product. In some cases ants use certain forms of the plant lice almost as

dairy cattle, carrying them to pasture and providing shelter when necessary. It has been shown that the ants act as guardians against certain predatory beetles. The following extract is from Professor Smith's Economic Entomology, and is a good statement of the case of the ant and the aphid: "It is a common thing to see ants crawling over leaves infested with plant lice, and it is often considered well that this should be so, under the erroneous impression that the ants feed upon the plant lice. In some cultivated fields ant hills abound early in the spring, the little mounds scarcely rising above the surface, being seen everywhere. We find next, shortly after, plant lice affecting the roots or leaves of the growing plants. In truth ants are protectors of plant lice; they are fond of their sweet excretion, and favor their increase and development in every possible way. The plant lice seem to feel they have nothing to fear and readily yield to the ants of their sweets whenever approached for that purpose. Some species of aphids are indeed practically dependent upon ants for their existence. Where some of them lay their eggs we have not yet been able to learn, but perhaps they simply drop them on the ground, where their color and size render them invisible to our eyes. The ants find, gather and carry them into their galleries, where they store them until spring. When vegetation starts and, if conditions are favorable, the eggs are taken where they can hatch normally, the young lice being afterwards carried to the plants on which they are to feed. An instance nearly like this, save that the young are carried over winter, we find in the lice infesting corn roots, and undoubtedly there are many others."

Many of the aphids are exceedingly limited in their choice of food plants, usually a single species confining itself to some particular plant and being found seldom, if ever, on any other. This feeding habit is especially true of most of the economic forms, a few of which will be taken up more carefully in the following pages.

THE WOOLLY APPLE LOUSE.

(Schizoneura lanigera.)

The Woolly Apple Louse is of especial interest to fruit growers, as it is one of the few that may be introduced into an orchard on nursery stock. This insect lives both on the roots and the stem of the apple tree. On the roots galls are often formed, while on the stems deep pits may be made in which great numbers of the woolly lice congregate. In the nursery, infested trees are often stunted and

Galls on the Elm produced by the Woolly Elm Louse. This louse is similar in many ways to the Woolly Louse of the Apple.

sometimes killed by this insect. While there are authentic cases of trees recovering normal health after being damaged by this insect, no reputable nurseryman ever sells stock infested with this pest. Infested trees in the nursery should be dug and burned. In the orchard it is sometimes possible to destroy the insects by boring or punching holes almost an inch in diameter and two feet deep around the trees at a distance of eighteen inches from the trunk. Pour an ounce of carbon bisulphide into each of six such holes and at once replace the earth over the opening. Another method which has proved successful against the apple aphids is to break the ground around the tree to a depth of at last a foot and apply twenty-five to thirty pounds of commercial fertilizer, containing not less than nine per cent of potash. If this is applied during a dry season the ground should be thoroughly soaked so that the full strength of the potash will immediately reach the affected roots. Where the insects show on the trunk they may be killed with a wash of whale oil soap or a ten per cent coal oil emulsion.

No planter should ever place a tree in the ground without a careful examination of both root and branch, and if any evidence of the woolly louse is found the tree should be discarded and either burned, fumigated or the roots dipped in a one to twenty solution of one of the miscible oils. Fumigation or dipping can not be regarded as invariably effective in treating this insect, however, and it is best to have nothing at all to do with it in any way.

A closely related form sometimes affects the elm and does great damage year after year until the tree is eventually killed.

APPLE LOUSE.

(Siphocoryne avenae.)

This insect feeds on the under side of the leaves of the apple, causing them to curl up. It also passes one stage of its life history on one of the field grains.

It is difficult to reach by spraying owing to the fact that the leaves curl so as to protect the lice on the under sides. Many small beetles and the young of some of the tree crickets are predaceous on this and other plant lice.

It is said that this louse is in reality a grain infesting species and that on alternate years only does the brood attack the apple. Two alternating broods would account for the annual appearance of the insect.

The Apple twig shows the eggs of the Green Apple Louse surrounding the bud. Magnified ten diameters.

Young Lice recently hatched from eggs shown on page 100.

Typical Aphids. The Red Louse of the Golden Glow.

APHIS MALI.

This louse often confused with the preceding is distinguished by the more nearly pear-shaped body.

Its method of feeding is the same as the Siphocoryne avenae.

In the fall the small and shiney black eggs are laid in clusters on the young shoots of the apple and pass the winter in that condition. Owing to their small size they are not easily detected and may often be distributed on nursery stock. As a precaution it is well to burn all the small branches trimmed from recently planted trees, as most of the eggs will occur on the newest growth.

THE CHERRY LOUSE.

This black louse is very similar in its habits and life history to the common aphis mali. It occurs principally on the cherry, working on the under side of the leaves. It is one of the lice liable to be distributed on nursery stock, owing to the fact that the eggs are laid on small branches and pass the winter in this condition. Where the insect occurs on nursery stock it will be found entirely practical to dip the ends of the branches in a bucket containing a ten per cent coal oil emulsion, a strong solution of whale oil soap or a decoction of tobacco stems. This insect is also like many of the other lice—heavily parasitized. A striking example of this form of insect control will be mentioned under our chapter on the parasitic control of insects.

VIOLET APHIS.

(Rhopalosiphum violae.)

In certain parts of the East violet growers have experienced considerable trouble with this reddish-brown plant louse. As yet it does not seem to have been distributed throughout the West, but it may appear in our greenhouses at any time. As violets can not be treated with tobacco smoke, used as a repellant for other forms of greenhouse lice, this insect must be attacked with hydrocyanic acid gas as outlined elsewhere in this report.

The Orthoptera.

The Orthoptera are chewing insects having a complete metamorphosis. The order includes the grasshoppers, roaches, crickets, etc. Some of these insects are of great economic importance, and some years do an immense amount of damage to growing crops.

Some of them have been regarded with fear by the agriculturist from the earliest times. The migratory locusts of the Bible and the Rocky Mountain grasshopper of our Western States both belong to this order and both are exceedingly injurious.

The Rocky Mountain grasshopper is one of the most injurious insect pests, in some localities of the West, that the farmers have to contend with. Like many other insects it is more dangerous in certain seasons—and certain years have gone down in history as periods of great destructiveness by this insect. The years 1867, 1873 and 1875 were noted as years when the Rocky Mountain grasshopper was particularly destructive. Fortunately this insect does not occur within the borders of Indiana, and we will probably have nothing to fear from its introduction.

GRASSHOPPERS.

There are many varieties of grasshoppers common to Indiana, some of which occasionally do considerable damage to field or more particularly garden crops. We have no species that has become sufficiently destructive to receive any extensive attention from the farmers, although several species occasionally appear in sufficient numbers to cause marked damage to field crops early in the season.

The most common of the Indiana grasshoppers and perhaps the most injurious is the Red Legged grasshopper—Melanoplus femur-rubrum. It occurs over the entire State and is to be found from the middle of May till late in the fall. In size this locust is about an inch long, of a reddish-brown color, and characterized by the marked reddish color of the legs.

Schistoceraca Americana.

This is the largest grasshopper occurring in Indiana. It often measures more than two inches in length with a wing expanse of more than five inches. These insects are of a reddish-brown color,

the wings nearly transparent, conspicuously marked and spotted with brown. This species is closely related to the migratory locusts of the Old World. From its habits of flight and from its large size it has gained the name of "Bird Grasshopper." I have found them commonly in the fields near Indianapolis as early as the middle of May, so it is possible that some of the adults pass the winter sheltered in old logs or other protected places. This insect frequently does considerable damage, particularly to the corn early in the season. Its migratory habits and its ability to make long flights render it difficult to control by any of the old methods of grasshopper destruction.

Common Bird Grasshopper—Natural size.

In the summer of 1907 I had considerable success in controlling this insect with the use of poisoned bran. The bran was poisoned by the addition of one part of paris green to one hundred and fifty parts of bran by measurement. The entire mass was moistened and placed in small piles around the fields where the grasshoppers were at work. The older method of controlling grasshoppers and one that is quite successful in handling the forms which do not fly far is by the use of what is commonly called the "Hopperdozer." This is simply a large, shallow pan about eight feet long and a few inches deep and having at the back a canvass curtain. The pan is filled with kerosene to the depth of about an inch, and is then dragged over the field in which the grasshoppers are working. Many of the insects fall directly into the pan, others in attempting to jump over are caught by the canvass screen and thrown back into the pan. Even though they should jump out, after coming in contact with the oil the insects will meet with certain death if even a

drop of the oil touches their bodies. This system of extermination has met with wide success throughout the West and the Northwest.

Whenever grasshoppers may become injuriously numerous in gardens they may be poisoned by the use of paris green and bran as outlined above or the plants on which they are working may be sprayed with paris green in water in the proportion of one pound to one hundred and fifty gallons of water.

OECANTHUS NIVEUS.

The Snowy Tree Cricket.

This insect is of a pale greenish white color and is about an inch long. The antennae are longer than the body and the entire insect has the appearance of fragile delicacy. They are one of the few members of the order that are of particular interest to the fruit growers, as its depredations are sometimes rather extensive in the raspberry and blackberry fields and occasionally in the apple orchard. The damage by this insect is of two sorts.

The first and most conspicuous injuries are those resulting from the laying of eggs in the canes of raspberry and other woody plants. I have often seen young apple trees in the nursery that have been badly damaged by the egg deposits of this insect. The eggs are laid late in the season and first the only evidence of damage is the series of rough punctures extending up and down the stem. Later the cane or branch above the egg deposit will die or be broken off by the wind. If these infested branches be gathered in the winter and burned many of the locusts will be killed and the numbers reduced for the succeeding season. Many trees besides the apple are sometimes damaged by the work of this insect. In fact, the list of trees subject to attack is much larger than is commonly reported. Besides the common fruit trees I have found it in practically all of our soft-fibered native trees and occasionally they are particularly injurious in catalpa plantings. Where the catalpas are damaged by the Snowy Tree Cricket the injury is usually at the tip of the branch in the young growth, and the only permanent result is to add an increased crookedness to this already notoriously crooked tree. Another and rare form of damage by this insect is that of eating holes in apples and other fruits. In some localities this damage occasions quite considerable loss.

Mr. Hale of this city has reported to me that for several seasons his apples have been badly damaged this way and there seems to be no doubt as to the accuracy of his observation.

Raspberry cane showing the ova punctures of the Snowy Tree Cricket.

Raspberry cane cut open to show the eggs deposited by the Snowy Tree Cricket.

This is one of the injurious insects that at least, in part, pays for the damage which it does by acting as a parasite on other insects. When the young hatch in the spring they are predaceous on many species of plant lice and doubtless destroy considerable numbers of them. However, the form is to be considered more as an injurious insect than as a beneficial one. It is controlled in part by our insectivorous summer birds eating the adults and by the downy woodpecker, which destroys many of the eggs in the winter time. I have often watched this small black and white woodpecker industriously at work ripping open twigs infested with the snowy cricket eggs and a subsequent examination of the work showed that it had been very thorough.

ROACHES.

There are several species of this common household insect that occur around kitchen sinks or wherever there are water pipes of any kind.

They can be readily poisoned by the use of borax intimately mixed with powdered chocolate. The insects are very fond of chocolate and eat the mixture readily. It can be dusted in small quantities in the crevices in the haunts of the insect. It possesses the advantage of being practically non-poisonous to human beings.

The insects are also fond of thoroughly ripe, or even rotten, bananas, and if a bit of this fruit is mixed with some paris green and placed where the roaches can get it, it will destroy large numbers of them.

THE WALKING STICK AND MANTIS.

The "Walking Stick" and "Praying Mantis" are two of the most curious insects which the entomologist will find in his field work. They both belong to the grasshopper family, but rarely occur in sufficient numbers to be of any economic importance.

The walking stick is a curious, wingless form to be found throughout the summer, usually in wooded districts.

Its long cylindrical body and angular legs give it the appearance of being an animated twig. When it is at rest it bears a distinct resemblance to the small branch on which it is placed.

The praying mantis is curious from the habit which it has of elevating its front legs as illustrated in the accompanying cut. It

Praying Mantis.

is from this prayerful attitude that it has derived its popular name. They are usually of even less economic importance than the walking sticks.

THE KATYDID.

The angular winged katydid is an object familiar to most people who give any attention to out-of-door subjects.

Its large, soft green wings are so near the color of the foliage that it is often difficult to see the insect without a very careful examination of the region from which its song seems to come.

It does not occur in sufficient numbers to be of much economic importance, but it is of interest because of the fact that its eggs are often taken by the uninitiated for the San Jose scale, to which they really bear no resemblance. The eggs are laid in a double row down the side of a twig or on a leaf, each egg overlapping the one below it like the shingles of a house. These eggs are often heavily parisitized and as a rule only a small number of those laid ever produce katydids.

Scales from the wings of Butterflies—Highly magnified.

Lepidoptera.

(Butterflies and Moths.)

The Lepidoptera, or scale-winged insects, are so called because of the fact that the wings are clothed with curious striated scales of microscopic size. When the insects are handled those scales rub off as a colored dust. Viewed through the microscope the scales are arranged on the wings as regularly as shingles on the roof of a house.

The butterflies and moths which make up this order possess many characters in common, though they often differ widely in habits. Butterflies may be known by the shape of the antennae, which are characteristically club shaped; by their diurnal habits—flying only in the daytime—and by the fact that they do not spin a cocoon, simply passing the resting stage as a naked chrysalis attached to some sheltering branch.

The moths possess more or less plume-shaped antennae, fly mostly at night, and, with few exceptions, spin cocoons in which to pass the winter.

Red Admiral, showing typical Butterfly structure.

The order includes some of our most important economic insects, most of which can be dealt with by the use of one of the stomach poisons.

CAMBERWELL BEAUTY.

One of the butterflies that we find flying about the woods in early spring is the Camberwell Beauty or the Mourning Cloak. It is one of the few butterflies that pass the winter in the adult condition, hibernating in sheltered cracks and crevices in old logs and hollow trees.

The handsome dark brown insects have on the border of the wings a broad light yellowish band, which makes them particularly conspicuous objects. The caterpillars feed on several varieties of native trees, but notably on the elm, and in many localities the larva of this insect is known as the Spiney Elm caterpillar.

The eggs are laid on the young twigs just before the buds open in the spring. The young larva begin to hatch in a few days and at once begin to feed on the opening foliage. At this period the caterpillars work in very definite colonies and may easily be eradicated by simply cutting off the infested branches and destroying the insects. Where they once become established on a large tree it is exceedingly difficult to control them, because it is difficult to get any spraying solution on to all the parts of the upper branches. Being distinctly leaf eaters, any of the arsenical sprays would be effective.

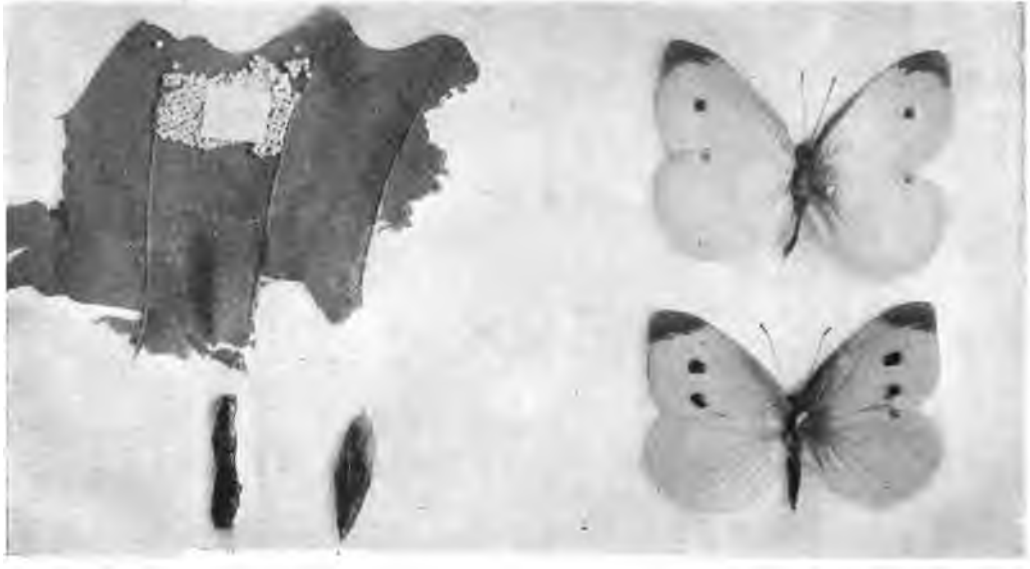
CABBAGE BUTTERFLIES.

This insect is one of the pests that was imported into this country from Europe, and has been widely distributed over the greater part of the United States.

The adult insects are about an inch and a half in expanse, and have creamy white wings with a black spot in the forewings of the male and two black spots on the forewings of the females.

The adult insects appear very early in the spring, having emerged from the chrysalis form in which they spent the winter. They later lay their eggs upon any plant of the mustard family, but prefer the cabbage. Often the first brood is developed upon native wild crucifers before the young cabbages are set out. The second brood is usually responsible for most of the damage done to the early cabbages.

The caterpillars are of soft, uniform green color, matching the shade and texture of the cabbage leaf. Their protective coloring is so perfect that they may readily be overlooked by any but a careful observer. Practically the only remedy that we have is to spray the



Showing the Life History of the common Cabbage Butterfly.

The common Swallow-Tailed Butterfly. Papilio Cresphontes.

Tomato Worm, Natural Size.

Resting Stage (Pupa) of Tomato Worm. In this condition the insect passes the Winter beneath the surface of the soil. Many of them will be killed by Fall plowing.

Adult of Common Tomato Worm. Characteristic Sphinx Moth.

Tomato Worm, showing cocoons of a parasitic Fly. Tomato Worms in this condition should not be disturbed, as the parasites are certain to kill them in a short time, and each infested Caterpillar will thus liberate a large number of adult parasites that will immediately seek out and destroy other Tomato Worms.

inflicting a severe "sting." This supposition is entirely unfounded and the caterpillars are altogether harmless to handle.

The larva are so large that they may readily be gathered from the tomato plants by hand and destroyed mechanically. Their green color, however, enables them to so perfectly match the foliage on which they feed that some little practice is necessary before the average observer is able to see them readily.

The larva of this insect is not to be confused with that of the Cecropia moth which, while green, is covered with a series of bright colored excrescences. The body of the tomato worm is smooth, and the sides are marked with a series of oblique white stripes.

This is one of the insects that is controlled by the work of parasites. Small parasitic flies lay their eggs on the body of the caterpillar, where they hatch and feed. Later these parasitic larva emerge from the body of the caterpillars, spin small white cocoons and remain attached to the host insect until they transform into the adults. Caterpillars so parasitized should not be destroyed, as it is desirable to encourage the parasites to as great an extent as possible.

CATALPA SPHINX MOTH.

Another species of the Sphinx moth that has recently come into prominence in Indiana is the one which feeds on the leaves of the catalpa. This larva differs from the common tomato worm in size, being smaller, and in the color markings. These latter vary from occasional black spots on a green ground to a broad velvety black stripe running the entire length of the back. I have seen many catalpa trees completely defoliated by this insect.

Frequently there is a second brood which appears later in the summer just about the time the catalpa has developed a second set of leaves. In a number of cases I have known catalpa plantations to be twice defoliated in the same season.

On small trees it is practical to control the insects by spraying with any of the arsenical solutions, or by hand gathering when the larva are small, as at that time they are inclined to feed in rather definite colonies. On large trees, however, especially in catalpa plantations, it is impractical to spray the trees and recourse must be had to some other means of control. This is to be found in the fact that all of the Sphinx moths pass their resting or pupal condition in the soil. Persistent cultivation of the soil around the infested catalpa trees will probably result in killing a considerable

Characteristic Catalpa Worm about natural size. This is the larva of one of the Sphinx Moths, hence closely related to the Tomato Worm.

Catalpa Tree defoliated by Catalpa Worm.

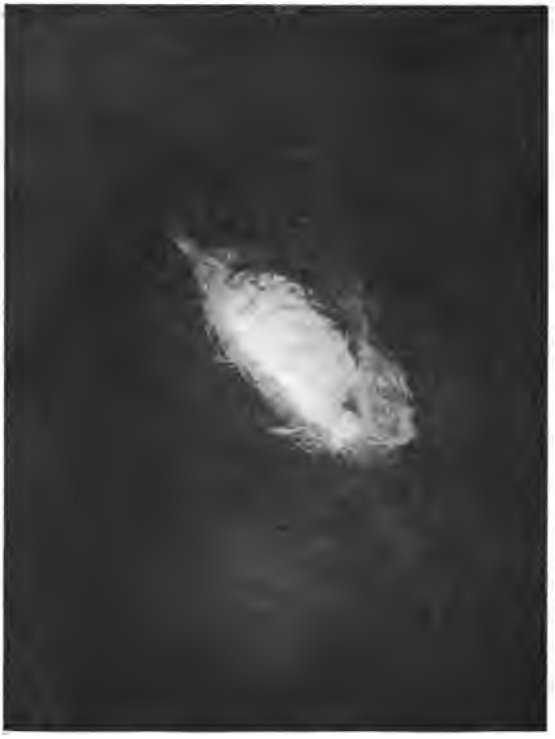
number of the insects. Unless this measure should prove practical it will mean that still another argument has been added to the already extensive list of arguments against the growing of catalpa for commercial purposes.

The accompanying illustrations adequately represent the sphinx moths in all the stages of their life history.

TUSSOCK MOTH.

This troublesome insect is usually periodical in its attacks on trees.

The moth winters in the egg state, and early in the summer the young larvæ hatch and immediately crawl to the foliage and begin



Cocoon of the Tussock Moth showing the attached egg mass.

to feed. The eggs are laid by the female moth on the old cocoons, and as these cocoons are frequently situated on houses and other objects away from the trees, the young can be kept from the foliage by banding the trees with some sticky preparation, which will keep

Horse Chestnut Tree defoliated by the White-Marked Tussock Moth.

them from crawling up the trunk. In winter the cocoons bearing egg masses should be gathered and burned so as to destroy all the young that are present. A favorite place for the situation of cocoons is under the overlapping weatherboards on the sides of houses. In Indianapolis the school children were interested in the work of collecting and destroying the cocoons of this insect. As a result, after one season's work the numbers of the moths were so reduced that in sections where they had previously been epidemic it was almost impossible to find isolated caterpillars.

In summer after the caterpillars make their appearance they can be destroyed by spraying the trees with paris green solution. This remedy has proved very successful in Indianapolis, but it must be thoroughly applied, and if washed off by the rain it should be repeated. The larva or caterpillar of this moth is one of the most beautiful of all the curious array of insects. It may be easily recognized by the presence of several tufts of white hair on the back, from which it takes its name of the Tussock moth. At the head are two long pencils of brownish hair, with a single similar one on the tail. The front part of the head is bright red in color and a couple of red glands occupy segments near the tail. The hairs of this caterpillar are barbed, and sometimes cause more or less irritation to persons of tender skin when they are carelessly handled.

PEACH BORER.

The eggs of the Peach Borer are laid on the bark of the tree near the surface of the soil, in early summer. About midsummer the young larvaæ hatch and at once enter the tree and begin to feed between the bark and the wood. By winter they have attained considerable size, and have produced a marked exudation of gum on the outside of the affected tree. In the spring they resume feeding until they have attained their full growth of more than an inch. A rough cocoon is then spun, in which they remain for a few days before emerging as adult moths.

The adults are what is known as "Clear Winged Moths," as their wings are, for the most part, not clothed with the characteristic scales covering the wings of most members of this order.

In infested trees the most practical remedy is to cut out the insects and destroy them. Often the trees will be considerably damaged by this process, but the peach possesses wonderful recuperative powers, and is more liable to recover from the surgical work

Young Peach Tree showing exudation of gum caused by the work of the Peach Tree Borer.

Peach Tree cut open to show work of Peach Tree Borer.

than from the work of the unmolested insect. On young trees the insects may be kept out by mounding up the earth around the tree during the period at which the eggs are laid or by using some sort of a protector which will prevent the insects from laying their eggs on the bark. Tarred paper, common newspaper, slips of veneer, and wire netting of rather fine mesh have all been used to prevent the borer from laying eggs on the lower part of the trunk. In some localities these preventive measures have been extremely successful.

There are several other species in this same family which bore in the wood of maples and several other varieties of fruit and shade trees.

Occasionally we find the older branches of the lilac infested by a similar form. In this case it is often good practice to cut out the bored parts of the shrub and destroy them, together with the contained insects.

BAG WORM MOTH.

This is one of the most curious insects which we have.

The young larvæ hatch from the eggs in the spring and at once make for themselves a small bag which they carry around with them for the rest of their lives, adding to it as their increased size may require.

When the insects reach their full size, usually late in summer, they attach this bag or cocoon to some convenient twig and enter the resting stage.

In the case of the female there are no wings developed and the adult insect never even leaves the cocoon—the eggs being laid inside of that structure. This gives us the exceedingly curious condition of an insect passing the winter in the egg state inside of a cocoon. This is one of the few insects that we have infesting conifers, and it is particularly destructive on the Arbor Vitae, where it frequently causes the death of the tree.

The insects may be gathered by hand in the summer or where they are actively feeding they may be destroyed by spraying with any of the arsenical preparations. The arsenate of lead will be found to be particularly valuable for this purpose. In the winter the cocoons may readily be gathered and destroyed.

Occasionally we find this insect very bad on the apple. In orchards that are regularly sprayed for the codling moth the bag worm will be taken care of as a mere incident to the destruction of the fruit infesting species.

Ash-Leaved Maple badly infested with the Bag Worm Moth. In this condition the cocoons can readily be gathered in the winter and destroyed. Summer work against the insects is often ineffective.

Cocoon of the Bag Worm Moth attached to a twig of Arbor Vitae, its favorite food plant.

FALL WEB WORM.

The eggs of the Fall Web Worm are laid on the smaller twigs of shade and fruit trees in the autumn and the insects pass the winter in the egg state.

These masses of eggs, adhering very closely to the stems, are easily overlooked and will be noticed only by an observer trained for the work. However a little practice will enable anyone to easily recognize the masses. They can be collected at any time during the winter and destroyed. If left unmolested the eggs hatch in the spring and the young caterpillars at once build a web in which they remain much of the time, feeding on the leaves enclosed in the web and on those adjacent to it.

The caterpillars vary considerably in their markings, some of them being almost entirely white while others are conspicuously marked with black stripes or dots. There is a corresponding variation of color marking in the wings of the adult.

This insect often becomes a serious pest on shade trees and fruit trees in orchards. One of its natural native food plants is the wild cherry and it can nearly always be found on this tree in larger or smaller numbers.

Often the webs of the Fall Web Worms remain on the tree as tangled patches of silk, caterpillar skins and castings far into the winter.

There are two broods of the insects, one occurring in the spring and one much larger brood in the fall. The second brood being much more conspicuous has secured for the insect the name of Fall Web Worm, though it often appears and does serious damage in the spring of the year.

CODLING MOTH.

No other insect annually causes the extensive damage to American fruit growers which can be attributed to the Codling moth. This insect was introduced into America from Europe something more than one hundred years ago, and it has spread over the greater part of the United States and Canada, wherever fruit is grown.

It has become of such universal distribution that it is impossible to produce perfect apples anywhere in this country without thorough and systematic spraying.

The adult moth appears in early spring at the time when the fruit trees are in blossom. The eggs are laid at the calyx end of the

Twigs bearing eggs of Fall Web Worm. In this condition they go through the winter.

Fall Web Worm at Work.

Fall Web Worm at Work.

Wild Cherry Tree, showing branch defoliated by Fall Web Worm.

young fruit at about the time the petals fall. The young larva hatch and at once proceed to the core of the apple, where they finally mature.

In Indiana there are two broods of the Codling moth—the first brood reaching maturity about midsummer. The second brood attacks whatever apples may be on the trees at that season.

There is a slight difference in the egg laying habits of the first and second brood. As already mentioned the first brood lays its eggs at the blossom end of the fruit. The second brood seems to prefer to place its eggs at a point where two fruits touch.

When full grown the caterpillars of the second brood emerge from the apples, seek a sheltered place on the bark of the tree and spin a cocoon in which they pass the winter.

Spraying for the Codling moth must be done regularly and systematically if effective work is to be accomplished. The first spraying with one of the arsenites should be immediately after the petals have fallen and before the calyx lobes have turned in. After the calyx lobes turn in or close it is impossible to get the poison where it will be eaten by the young larva. The second spraying should follow the first in a week or ten days. Should a rain immediately follow the application of the second spraying the trees should be gone over for a third time. In fact the exact time to spray must be determined very largely by the weather conditions at the blossoming period.

Spraying against the second brood may be done in the summertime—at the time of the appearance of the adult moths, which must be watched for carefully in order to determine the proper time for this work.

CLOTHES MOTH.

There are several species of small moths which cause a great deal of damage to woolen fabrics.

The adults are yellowish winged insects of little more than one-fourth of an inch in length, and are often seen flying about the house early in the evening. The caterpillars commonly called "moths" feed upon all manner of fabrics containing wool, seldom attacking the vegetable fibers, such as cotton and linen.

Where a house becomes badly infested with these insects they are rather hard to control. Persistent work will eventually get rid of most of them. Spare rooms and attics where old clothes are kept for an indefinite period often become breeding places for these in-

sects, from which they spread over the other portions of the house. All such storage places should be frequently and thoroughly cleaned out and the garments contained therein should be carefully shaken and beaten in the open air. It is not necessary, however, that infested clothing should be left in the open air for any considerable

Photograph of a convenient mount for insects which are to be used in Nature Study Work in the Public Schools. This mount is actually in use in Shortridge High School.

period of time, for contrary to popular belief this insect is not killed by exposure to the air and sunlight.

Woolens or furs which are to be stored during the summer should be packed in tight paper bags in which there is a liberal supply of moth balls (Naphthalin), which is exceedingly distasteful to this as well as to many other insects.

GRAPE BERRY MOTH.

This small moth, which infests the fruit of the grape, sometimes becomes so bad as to render grape growing almost impractical.

The small larva feed inside the berries of the grape and often

migrate from one berry to another, so that we find whole clusters of fruit literally honeycombed by the work of the insect.

The moths pass the winter in the rubbish and leaves around the grape vines and many of them will be destroyed by thoroughly cleaning the vineyard and burning all the accumulated trash.

Spraying will also be effective if applied thoroughly and often, beginning at the time when the grapes are about the size of a pea.

At this time, too, considerable good can be accomplished by sacking the grapes—that is, tying each bunch in a small paper bag.

Hive of Bees, showing large numbers of the colony around the door of the hive.

Hymenoptera.

(Bees, Wasps, Ants, and their kin.)

The order Hymenoptera contains some of our most important economic insects, most of which are to be listed on the side of the beneficial forms. They include practically the only examples of domesticated insects—the bees. They have always been favorite

Characteristic Insect Galls of the Goldenrod.

subjects for study by the naturalist, as they exhibit a degree of intelligence equaled by but few of our so-called higher animals. The members of the order are furnished with two pairs of membranous wings, the mouth parts are furnished both with chewing and sucking organs—the tongue being developed for the latter purpose—and

the metamorphosis is complete. In addition most of the members of the order have the females provided with a sting located in the tip of the abdomen.

BEES.

The bees are among the highest developed of all of the insects, and possess a social organization that might easily be copied by men without detriment, though doubtless their successful socialistic communities are rendered possible only by the fact that each bee is like every other bee—unlike men who have developed individuality.

There are so many questions relative to bees and to bee keeping that we will not attempt to even begin their discussion in this report, though the encouragement of the bee keeping industry should naturally come under the direction of this department. (See article on Bee Inspection.)

ANTS.

The sluggard has often been referred to the ant as an object lesson in thrift, but should he copy that industrious insect he would develop into a poor economist, but a first-class thief. While the ants exhibit high intelligence it is not of a very attractive sort and most of their endeavor is directed toward securing what they need at the moment at the least possible expense to themselves. Ants seldom make any provision for winter, and depend upon robbery for their living.

These inquisitive insects often invade houses in considerable numbers and during the summer may become very troublesome pests. It is often difficult to keep them out of our houses, but if food is kept in tight receptacles where they can not get at it, they will not be so liable to make their appearance. Refrigerators may be protected by placing each leg in a small pan of water across which the ants can not make their way. The very minute reddish-brown ants can be trapped by the use of sweetened bread. When this food has become thoroughly covered with the pests it should be destroyed by burning. This plan will rid a house of the insects in a short time if it is followed faithfully.

Layer of Cells of Hornets' Nest, showing the young Hornets about to emerge.

Mud Nest of one of the Solitary Wasps.

Common Garden Spider, distinguishable from insects by the presence of four pairs of legs instead of three and by the non-articulated head.

WASPS.

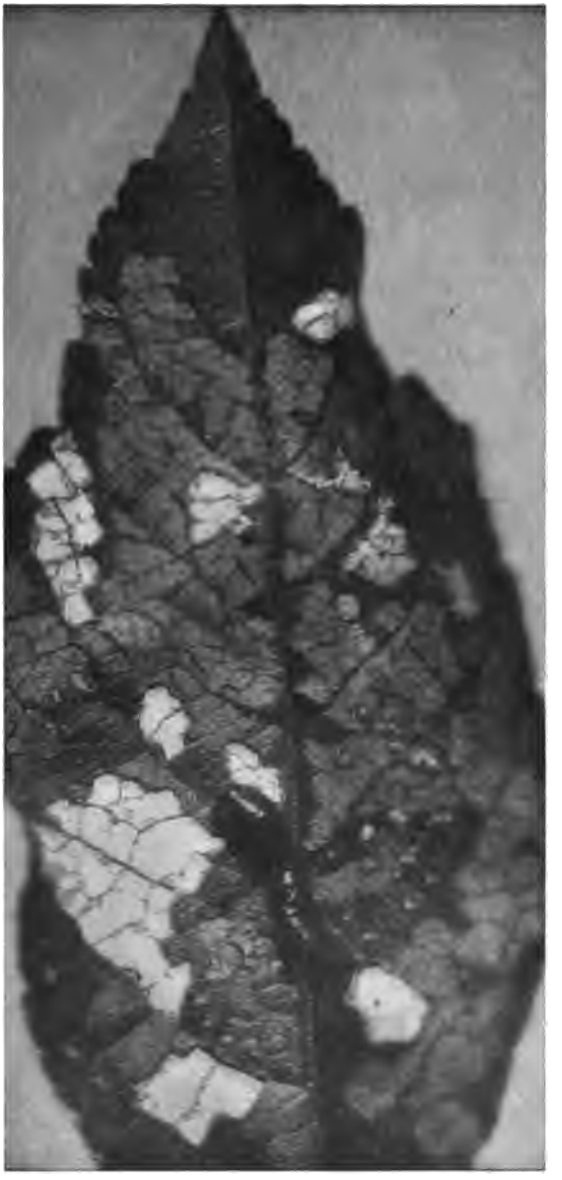
Many of the wasps possess a slight economic value as destroyers of caterpillars. The larvae of many butterflies and moths are systematically gathered and stored in the egg cells of the wasps, to be used as food for the young larvae. Often spiders are stored in the same way.

THE SAWFLIES.

As a rule the larvae of the hymenopterous insects are helpless creatures, depending for their existence on whatever food is brought to them by the adults. The larvae of the sawflies however are quite independent and exist as open feeders on many kinds of foliage. The locust sawfly feeds on the leaves of the black locust, the wisteria and many other kinds of leguminous plants. Its feeding habit is curious. The young larva, which closely resembles a caterpillar, cuts a small flap out of a leaf and bends it over so as to make a snug cell in which to pass the day, emerging to feed on the adjacent tissues at night. Plantations of locust are often more or less damaged by this insect and where the trees are small enough and planted far enough apart to be sprayed, any of the arsenic preparations will be found effective. Where they damage ornamental plants they may be gathered by hand.

The pear tree slug is another of the sawflies that often does considerable damage both to the foliage of the pear and of the cherry. The eggs are laid by the adults on the leaves of the two trees mentioned, at the beginning of summer. In a short time the young larvae have hatched and at once begin to feed on the plant tissues. The larvae are at first white but later become covered with a slimy dark green exudate. They are readily poisoned with paris green or may be killed mechanically by the use of dry powdered lime. The dust gathers on their bodies and they are soon killed.

Several species of "Horn-tails" are native to America and are closely related to the sawflies. One of the most common forms is one that often does great damage by boring in the wood of the native hard maple. The adult insect is black and has the body banded with yellow stripes, the wings being of a dull smoke color. The eggs are laid by the female under the bark of the tree, which she is able to pierce for a distance of half an inch or more. The young hatch and mature inside the tree, emerging as adults late in summer. The treatment for this insect of course is the same as for any other boring form—dig out the insects. An interesting thing



Cherry Leaf, slightly enlarged, showing the work of the common Cherry or Pear Slug—the larva of one of the Saw Flies.

about this insect is that it is largely controlled by another hymenopterous insect known as the Thalessa fly. This large "fly," one of the largest of the Ichneumon flies, is provided with an ovipositor of great length. With this organ the adult female explores the cavities of an infested maple and when she comes upon the burrow of one of the horn-tails she deposits an egg. The resulting larva investigates the borings of the horn-tail and when the young borer is found the thalessa larva attaches itself to it, sucks its blood and eventually kills it.

Tomato Worm killed by parasites. Most of the attached cocoons have at this time hatched out.

There are several other forms of Ichneumon flies besides the one mentioned above and all of them are beneficial, being parasitic on caterpillars of various kinds.

The Braconid flies are often popularly called Ichneumons, from which they differ slightly, principally in the venation of the wings. They are all parasitic.

A characteristic form attacks the common tomato worm. The eggs are laid in the body of the caterpillar by the adult "fly." The young hatch and feed inside the body until they reach their full

growth when they come to the surface and spin small white cocoons which remain attached to the caterpillar. In this condition the little cocoons are often taken by the ignorant to be the eggs of the tomato worm and are killed as such. As a matter of fact, infested caterpillars should not be molested as they are almost certain to die before transforming to the adult condition if not before they enter the pupal state, and if they are left alone all of the attached cocoons will produce adult parasites to attack other caterpillars.

Coleoptera.

The beetles are to be known by the horny character of the two forewings which are thickened into protective organs called elytra. These "wing covers" are never used in flight and when the insect is at rest they meet in a straight line down the middle of the back.

Horned Passalus (Passalus cornuta). Typical Beetle.
Enlarged about four times.

Since some twelve thousand different kinds of beetles have been listed from the United States and Canada it is obviously impossible in this brief list to do more than make reference to a few of the more important economic forms.

The beetles listed herein are arranged according to no special system of classification.

POTATO BUGS.

The Colorado Potato Beetle is too well known to need any specific description here. The adults, which hibernate during the winter, lay their eggs on the foliage of the potato as soon as it is above ground. The young larva reach the adult stage about midsummer and provide for a second brood. Paris green is universally used to control this pest and may be used at the rate of one pound to one hundred gallons of water or even stronger. On small fields the insects can be gathered by hand and destroyed.

ROSE CHAFER.

This beetle is occasionally reported as occurring in this State in considerable numbers but I have never seen them doing any material damage. Professor J. B. Smith speaks of them as being exceedingly troublesome on grapes. His account taken from his Economic Entomology is as follows:

"Occasionally for a series of years the insects appear in ever increasing abundance until the swarms are so great that they ruin, not only vineyards, but orchards and gardens, eating almost every kind of fruit and

Male and Female of one of the common Beetles injurious to Grapes.

flower. In the presence of such swarms we are almost helpless and insecticides are of no possible use. No contact poison kills them and the arsenites or other stomach poisons act too slowly, as two or three days suffice to ruin a vineyard. Lest this seem strange, I will state that I have

seen on hundreds of acres of vineyard every vine bearing multitudes and every bunch of blossoms from two to ten, or even more beetles. I have counted over twenty on a single apple, and a full blown rose may bear as many as thirty or even more. We are reduced to actually collecting the specimens from the vines by means of funnel or umbrella-shaped collectors, adapted to the method of cultivation in use. They drop readily when the vines are jarred and the collector should be so made as to roll them to the center and into an attached pail containing kerosene. This must be done, not only daily, but continuously, for several days, until the flight is over or the grapes have set, for well set grapes are rarely eaten. Fortunately a period of abnormal increase seems to be followed by a period of decrease, though the lengths of the periods have not been ascertained. The larvae feed in light land on the roots of various plants, but principally on grass. They pupate in the spring, shortly before changing to adult condition, and by plowing infested sod at this time a large number can be destroyed. When only moderate numbers occur, lime often serves to protect the plants, or, better, the Bordeaux mixture, which is distasteful to them."

ELM LEAF BEETLE.

Throughout the east this imported pest has caused vast damage to the elms, both along the city streets and in the open. The small brownish beetles lay their eggs in the spring on the young growing sprouts of the elm. In a few days the young black larva emerge and at once begin to feed on the tender foliage. As the larva grows it develops yellow markings until, when it reaches its maturity, at the end of two or three weeks, it is an almost uniform yellow color. The insect passes the pupa stage in the grass about the base of the tree and at that time may be killed in large numbers by the use of hot water. Arsenate of lead is valuable against this pest, but since the beetle often infests large trees it is very difficult to successfully fight it.

JUNE BEETLES.

The June beetle or "June Bug" is a common insect late in spring or early summer.

The larva live in the sod, feeding on the roots of grass and other plants and are the common "white grubs." Serious damage is often done to pasture lands. Deep fall ploughing and the use of Kainit at the rate of half a ton per acre will drive out most of the insects.

The adults are night flyers and often injure the foliage of trees and shrubs. During the last season some of the white ash trees in Crown Hill Cemetery were completely defoliated by this beetle. Their work being done at night it is sometimes puzzling to the ob-

Ash Tree defoliated by the adult of the common May Beetle.

server, who is unable to find an insect at work during the day. As a rule the damage is done early in the evening between dusk and ten o'clock. Arsenic in any form is, of course, effective.

Typical work of the common White Grub. Usually the larva of the June Beetle.

The complete life history of the several species is not clearly recorded either as to the length of the larval period or as to the time of emergence of the adult. The latter seems to vary considerably and I have found recently transformed specimens from May till mid-autumn.

FRUIT TREE BARK BEETLE.

The Fruit Tree Bark Beetle is a pest that has recently attracted a great deal of attention.

It is a small insect and attacks practically all sorts of fruit trees. As a rule, however, this borer does not bother healthy trees; confining its work to trees that are already weakened by some other cause. Trees that have been damaged by the San Jose scale are especially liable to be attacked by the Fruit Tree Bark Beetle, and it never fails to complete the work which the scale has started.

Cherry Tree showing characteristic exudation of gum following the work of the Fruit Tree Bark Beetle.

The beetles work between the wood and bark, and on cherry, plum, and peach cause extensive exudations of gum. When the adult beetles emerge they leave a clean-cut round hole which gives the tree the appearance of having been shot at with a shotgun.

Preventive measures against this insect consist in keeping the orchard in as good a state of cultivation as possible. Healthy trees

Elm Tree at Vincennes, Indiana, killed by the Elm Tree Borer.

are seldom attacked, infested trees should at once be cut and burned. A slight infestation on an otherwise apparently healthy tree calls for an investigation. The infested branches should, of course, be cut out and if any prior injury be found, steps should be taken to remedy the trouble.

There are several generations of the insect in a season, and during the summer the beetles may be found in all stages of development.

THE ELM TREE BORER.

Several years ago in a report to the State Board of Forestry I made mention of the Elm Tree Borer in the shade trees of Vincennes. This destructive beetle is closely related to the round-

Hickory Wood showing the common Powder Post injury caused by small Wood-Boring Beetle.

headed borer of the apple. When a tree becomes infested the beetles quickly girdle the stem; the leaves turn yellow and fall and the tree dies.

The eggs are laid on the bark in June or July and at this time a repellant wash would prove useful in protecting healthy trees in

an infested neighborhood. All dead or dying elms suspected of being infested with this beetle should be cut and burned, thus destroying the contained larva.

THE POWDER POST BEETLES.

This small boring beetle is often very destructive to seasoned hickory. Tool handles, ladder rounds, rustic furniture, etc., all come in for their share of damage by this beetle. I am, at present,

Showing external evidence of work by Powder Post Beetle.

experimenting with various systems of treatment to prevent the work of this insect, but as yet the matter has not yielded definite enough results to justify space here. A bulletin will probably be issued on the subject later.

PLUM CURCULIO.

Among economic insects this small beetle deserves a place not far below that of the Codling moth, for it annually causes extensive losses among the growers of plums, cherries, peaches, and apples. The beetles are about one-fourth of an inch in length, heavy set, with four raised places on the wing covers. In color they are mottled brown and black.

The adults hibernate through the winter and make their appearance in early spring, feeding on the opening buds and tender leaves. The eggs are laid in crescent-shaped punctures made in the fruit after it is well set. When the young larva hatch they eat their way to the center of the fruit, thus being, at all times, beyond the reach of any poison. The adults are not extensive feeders and are but little controlled by the use of arsenic sprays. These facts combine to make this one of the most difficult of all insects to control.

Orchards in which chickens are allowed to run are noticeably less bothered by the curculio than are orchards from which chickens are excluded. In one plum orchard an experiment was tried to determine the thoroughness of this "chicken control." Several Burbank trees were selected and fenced in with chicken netting. A dozen hens were placed in the enclosure and remained there during the season. Each morning the trees were shaken. As a result the trees in the outside orchard had less than a third of the normal crop while those inside were broken down with fruit.

In my opinion poultry raising cannot be overlooked as the most important factor in the control of this insect.

In apple orchards the curculio does not usually do any extensive damage, owing to the fact that few of the beetles are able to develop to maturity in the fruit of the apple.

When the eggs are laid in plums the young larva hatch in a few days and by the last of July the insects are mature. Infested plums invariably fall to the ground and when the adult insect emerges it seeks some hiding place and is not seen till the following spring.

SCAVENGER BEETLES.

These "burying beetles" derive their name from their habit of excavating below small dead animals and gradually interring them. The eggs are laid in the object thus buried and the larva feed upon it. In this way the beetles do a distinct beneficial work, though it is doubtless of small importance.

LADY BUGS.

These small, turtle-shaped beetles are among the most important of all of our beneficial insects, for nearly all of them are predaceous on injurious insects.

The "Lady Bugs" can usually be easily recognized by their form or by their color, which is usually some combination of black with red or yellow.

These insects are predaceous both in the larval and adult form and at least two species are known to feed on the San Jose scale. More extensive mention of this has been made elsewhere in this report.

DERMESTIDS.

No one has ever camped in the woods for any length of time without making the acquaintance of the "larder beetle" (Dermestes lardarius) though doubtless he was not recognized by name when he emerged from some loaf of bread or side of bacon on which he had been making his dinner. Stored provisions of all kinds are subject to the attack of this beetle and it often becomes a distinct pest in smoke-houses.

They are difficult to exclude by screening but may be controlled by the use of poisoned bait. Simply expose in a convenient place a bit of meat (preferably bacon) which has been dipped in any solution of arsenic (or which has been dusted with borax) and large numbers of the beetles will be killed.

There are several species of similar habits.

The Carpet Beetle (Anthrenus scrophulariae) also belongs to this group. The adults pass the winter in sheltered places out of doors and in spring are often found on the blossoms of certain shrubs. I have gathered them in large numbers from the open flowers of the Physocarpus opulifolius. At their first opportunity they enter houses and lay their eggs on any woolen articles. It is from the tufted larva that this insect has received the name "Buffalo Moth." Moth balls in woolen clothing serves as a preventative, as it does of the common clothes moth, for which see a more extended discussion of this subject.

Where these beetles infest carpets, all floor coverings should be completely removed and cleaned and the floors carefully scrubbed with hot water. A liberal use of gasoline is valuable both on the carpets and on the floor. The presence of this insect is an additional argument against the use of carpets as floor coverings. Many other arguments might be brought against them on the score of sanitation.

CLICK BEETLES.

These insects are readily recognizable by a peculiar structure on the underside of the body which enables the beetle, when placed on its back, to spring quite a distance into the air. The larva of these jumping beetles are commonly known as "wire worms," deriving their names from their hard, glossy, cylindrical forms. In this

Black Locust Borer Working in Young Tree.

stage they are familiar to every farmer and are a recognized pest in grass lands. The larva sometimes require as long as three years to attain maturity and change to adults in the fall of the year. The adults then remain in the soil until spring when they lay eggs. Fall plowing and a liberal use of any fertilizer running high in potash will have a tendency to cause the beetles to leave the locality.

BORING BEETLES.

The Flat Headed Apple Borer and the Round Headed Apple Borer are both serious pests to the commercial orchardist. As a rule when these beetles gain entrance to a tree they must be cut out

with a sharp knife. If the work is done carefully and slowly it can be made very effective, but in the hands of a careless workman the cure is liable to be worse than the disease.

Preventative measures against boring insects are not of much value unless persistently applied during the entire period of egg laying. Most of these borers lay their eggs on the bark of the tree during the months of June and July.

Black Locust Tree Cut Off by Locust Borer.

The Locust Borer has, perhaps, attracted more attention in Indiana than any other boring insect. It lives exclusively in the stems of the Black Locust and it often occurs in such numbers as to render the growing of this valuable tree about impossible. In a section known to be infested with this insect it is pure folly to attempt to grow locust trees. I called attention to this fact several years ago and today I can point to any number of failures in locust growing which have been caused by this insect.

There is no remedy for trees which are infested and no practical method of preventing infestation. The insects are of universal distribution throughout the State, though a few localities seem to be less seriously infested than usual. The adult is a handsome brown beetle prettily marked with yellow. It is always to be found on Golden Rod in late summer or fall. A species of the same genus (though of small economic importance) bores in Hickory. The adults of this species appear in spring instead of fall.

One of the Common Ground Beetles.

Diptera.

(Flies.)

The Diptera or flies may readily be recognized from any other class of insects by the fact that they possess but a single pair of membranous wings. The order includes all of the insects commonly known as flies and mosquitoes and gnats and also it includes the fleas, which are generally regarded as degenerate flies which have lost their wings as a result of parasitic habits.

Most of these insects possess an economic importance due to the fact that they are direct carriers of disease among human beings.

FLEAS.

Houses often become infested with these pests which breed in rugs, carpets or even in the cracks in uncared for floors. Dogs or cats are usually responsible for their distribution, but they may readily be carried by rats and mice into houses where no domestic animals are permitted. When a house becomes infested the floors should be thoroughly cleaned and scrubbed with hot water and then liberally soaked with gasoline. The floor coverings must be thoroughly cleaned and beaten and then a careful watch kept for fear that unhatched eggs might have escaped the cleaning process.

When fleas infest cats and dogs they may be gotten rid of by washing the animals *often* with strong carbolic soap. Simply an occasional washing will not do, for many of the eggs are not killed or removed by the soap and in a few days they hatch and start a new generation of the insects.

Fleas have recently attracted considerable attention owing to the present Bubonic plague scare. It is now known that the plague is often spread by the fleas which infest sick rats, these rodents being very subject to the disease. In San Francisco and other cities of the Pacific coast, a systematic war has been waged against the rats, and as a result thousands of them have been killed. This is one of the preventative measures taken to head off a possible epidemic of a disease that is regarded as one of the most fatal afflictions of mankind. In countries where leprosy exists fleas are undoubtedly a means of its distribution. In almost any leper colony it is possible to find rats showing unmistakable signs of the disease,

and they are invariably infested with fleas. Even in our own locality it is probable that the common fleas of our household pets are responsible for the spread of some of our common contagious diseases. This is particularly true of the fleas infesting cats—felines being more inclined to be promiscuous in the matter of the company which they keep than are dogs.

MOSQUITOES.

The mosquitoes are also interesting in their relation to the public health, being entirely responsible for some of the most dangerous diseases. In the South the so-called yellow fever mosquito is the sole means of the spread of that disease. As a result of the understanding of this fact the breeding places of the insects have been destroyed, and where annual epidemics were formerly the rule a case of the fever is now seldom seen. This condition was brilliantly illustrated in the case of the city of Havana before and after the American intervention. Under the Spanish rule the city was a pest-hole of undrained sewers, stagnant gutters and filthy out-buildings and cisterns. All of these places provided abundant breeding places for the mosquitoes and in the unscreened hospitals they had unhindered access to the patients already sick with the yellow fever. It was then but a step to the general infecting of any healthy individual whom the mosquito might chance to bite. One of the first changes instituted by the Americans was a thorough cleaning up of all of these filthy places, and as a result the fever-carrying mosquito was deprived of his breeding grounds. These measures, combined with the careful screening of all fever patients so that mosquitoes could not get to them, has resulted in practically exterminating the disease in the city of Havana.

Indiana was noted in the early days as one of the worst places in the country for "the shakes," "chills and fever"—malaria. It was noticed, too, that the settlers who built two-story houses and slept in the second story, were not nearly so often ill with the disease. It remained for the scientist to explain the exact reason for this long after it was first noticed. Malaria is caused by a microscopic parasite working in the blood of man and this parasite has to pass one stage of its development inside the body of a mosquito belonging to the genus Anopheles. No other kind of mosquito will serve the purposes of this fastidious organism—and then the mosquito passes the parasite on into the blood of man when he bites. The exemption of the second-story sleepers is explained by the fact

that the Anopheles mosquitoes never fly high above the ground, seldom entering second-story windows. The Anopheles or malaria mosquito may readily be told from the common mosquito (Culex) by the fact that the latter insect when at rest has the body nearly parallel with the surface on which it rests and the head is bent at a sharp angle. The Anopheles when at rest holds the body almost perpendicular to the object on which it rests. Many species of Culex also have the habit of elevating the hind pair of legs when at rest.

All mosquitoes breed in standing water—and nowhere else. The obvious method of dealing with them is to prevent their development either by draining their breeding places or by some method of destroying the young before they reach maturity. This latter can readily be done by the use of coal oil on the water containing the young larvae. A small quantity of oil will spread in a thin film over a great expanse of wet marsh and as the insects must come to the surface to breathe they will be killed in vast numbers as soon as they come in contact with the oil.

In cities mosquitoes often breed in poorly-drained sewers, cisterns, rain barrels, roof gutters, and even in empty tin cans or any other receptacle capable of holding water for a few weeks' time. A little attention to the drainage conditions will undoubtedly result in a considerable reduction of the numbers of these pests in any locality. In New Jersey, Prof. J. B. Smith has caused much work of this kind to be done, and as a result of his efforts many localities that were formerly noted for their abundance of "Jersey Mosquitoes," are now practically free from the pests.

FLIES.

The common house-fly is one of the most annoying of household insects and like other members of this order it deserves its share of condemnation as a carrier of disease.

House-flies breed in all manner of filth and are especially liable to be found in stable manure. The fact that they also breed in human excrement makes them ready carriers of typhoid fever.

It is a universal practice to keep this pest out of our houses by the use of door and window screens, but it would not take a great deal of co-operation on the part of the members of a community to almost exterminate this insect in a given locality. In a city supplied with an adequate sewer system about all that would be required would be the keeping of all stable manure in tightly-screened

boxes and compelling its frequent removal. In my own locality in Indianapolis there are now no horses kept by householders, for some distance around my residence and there is a decided difference in the numbers of flies with which we have to contend now and in the numbers present when several horses were stabled in the neighborhood.

At Washington the Department of Agriculture has carried on some experiments along the line of fly control through the proper disposal of stable manure and their results as far as published indicate that the matter is entirely possible.

Even regardless of his undoubted ability to carry disease, the fly is a nuisance great enough to justify almost any measure to secure his extermination or control.

HESSIAN-FLY.

One of the members of this order that is of direct importance to the farmer is the Hessian-fly, which so often is destructive in the winter wheat. This small brown fly lays its eggs on the stem of the wheat after it is well above ground in the fall. By winter the insect is well grown and rests till spring, when it changes to the pupa state and later to the adult. These adults then lay eggs in the growing stalks causing them to become weakened and often to fall over. After the grain is cut the larval flies will remain in the stubble during the summer, the adults emerging in time to lay their eggs on the fall wheat. Insecticides are of course impracticable in dealing with an insect possessing such feeding habits and we are forced to attempt the control of the insect by farm practice. The infested stubble should be burned over to destroy the larva or it should be ploughed under. Burning is more thorough. Then the wheat should be planted as late as possible in order to force the insect to lay its eggs on some other plant.

Normal Bed of Healthy Ginseng Growing Under Cultivation in Southern Indiana.

Cultivated Ginseng Bed Showing the Damage Caused by Damping Off—A Bacterial Disease.

Carnation Plant Showing Work of the Root Rot.

THE DISEASES OF PLANTS.

All living organisms, from the highest to the lowest, plants as well as animals, are subject to the condition which we call disease. A plant disease is an abnormal, neglected condition, brought about by the action of some parasitic fungus or bacteria, or it may be merely a physiological condition occasioned by the condition of the soil or atmosphere in which the plant is situated.

The same environments which induce disease in the higher animals can be expected to exert a similar influence on plants. Susceptibility to disease is governed largely by the vitality of the organism, and if a man or a tree has not proper food and drink and proper air to breathe then they at once become the mark for an army of disease-producing bacteria and fungi. As a rule parasites do not attack a host until after the host has become weakened from some external physical influence. A man in perfect health has nothing to fear from typhoid fever; most dwellers in cities live in an atmosphere more or less infested with tuberculosis germs, while the bacteria which cause lockjaw are of universal occurrence.

It is only when the individual has become weakened from a long period of severe effort or from dissipation that typhoid is enabled to affect the intestinal tract. Tuberculosis attacks only the tissues that are weak either from exposure or from hereditary causes and it is only when the protecting skin is ruptured that tetanus becomes a reality.

The offspring of diseased parents, either plant or animal, are liable to inherit, not the disease itself, but the tendency to contract the disease. Tuberculosis was, for a long time, supposed to be an hereditary disease, but after it became known that it was a true bacterial trouble it was obvious that the old theory was wrong. As a matter of fact tuberculosis is hereditary just as much as weak lungs are hereditary, and a child with hereditary weak lungs living with tubercular parents is pretty certain to develop the disease sooner or later. This is the reason why tuberculosis "runs in families" and why it was formerly supposed to be hereditary.

Following the same line of reasoning it is easy to see why the offspring of a long line of healthy parents, animal or plant, will develop what we call a *disease-resisting* type. This is a matter that among men will be slow to work out, simply because men are slow

Lilac Leaf covered with Lilac Mildew. This and similar fungi often cause considerable damage to other plants—notably the Catalpa.

A Fungus Gall Undetermined as to Origin—on the Hickory.

to accept new ideas and are reluctant to admit that the same physiological laws govern their lives as govern the existence of the plants of the woods and fields.

The question of plant breeding to secure healthy types has already been the subject of much work by agricultural botanists, and as a result we have varieties of rust-proof wheat, blight-proof pears, plums that are not affected with black knot, and many other evidences that the theory is a correct one, and as yet the work along these lines is still in its infancy.

Apple.

Anthracnose, or Bitter Rot.

(Gloeosporium fructigenum.)

A disease characterized by small, dark, sunken spots in the fruit and is a serious trouble in most apple districts. The brown spots have an intensely bitter taste and should be removed before eating.

Apple Infested with Bitter Rot—a Contagious Fruit Disease.

In stored fruit this disease will spread from apple to apple and care should be taken to remove all infested fruits before putting them away for the winter.

The fruit should be sprayed shortly after the blossoms fall and at intervals of a few weeks thereafter with the Bordeaux mixture.

Blight.

(Micrococcus.)

This is a bacterial disease of the pear and apple. The affected parts die, the leaves remaining on the branch and turning black.

In Indiana this trouble is far more common on the pear than on any other tree and it is seldom you will find an orchard that is not troubled with it to a certain extent. The remedy is to cut *and burn* all infested parts and to refrain from cultivation of the trees. Cul-

Apple showing Three Distinct Regions of Infections from Bitter Rot. Notice that each infection starts from a central puncture in the skin of the apple, through which the spores obtain entrance to the fruit.

tivation produces excessive growth of tender tissues which are easily attacked by the bacteria. The growth in a neglected orchard is slower and the wood produced is harder and firmer and less liable to be injured by the disease.

Certain varieties of pear are less liable to disease than others. The Kiefer is one of the hardiest kinds and is but little subject to this trouble. Recently there have been some new varieties introduced and advertised as absolutely "blight proof." It will require further testing to prove this assertion though it seems to be correct so far.

Young Apple Tree with roots affected with Crown Gall, showing the great development of fibrous roots which sometimes accompanies this disease.

Apple Tree shown on page 175 with the fibrous roots removed, exposing the characteristic gall surrounding the root crown.

Specimen shown on page 176 cut open to show the characteristic gall structure.

Crown Gall.

This common disease of the apple, which is fully illustrated in the accompanying cuts, often damages nursery stock to a very considerable extent. It was formerly supposed to be caused by one of the slime moulds, but recent work has shown it to be due to the presence of a specific bacterium.

There seems to be no satisfactory method of preventing its occurrence on nursery stock, but planters should use care not to set out any infested trees.

The condition known as Hairy Root sometimes occurs on the same plant with the Crown Gall, but the relation of the two diseases, if they are two diseases, is not clearly known.

Crown Gall is distinctly a root disease and should not be confused with any other knot disease which causes more or less deformation of the trunks of apple and other trees.

Nectria.

This fungus attacks many varieties of trees, including the apple. During the season of 1907 it was found in injurious quantities in several Indiana nurseries. But the inspection of the past season seems to indicate that the disease is now completely controlled in the former infested places.

The first appearance of the disease is as a slight sunken oval area extending lengthwise on the stem of the tree. The external skin remains intact but is distinctly depressed. Often this depression will extend completely around the tree, causing its death. All nursery stock should be carefully examined before being planted, and if the disease is found the affected specimens should be destroyed.

The accompanying illustration shows the characteristic appearance of the work of the fungus on the maple.

Rust.

This leaf disease of the apple is caused by a fungus which passes one stage of its life cycle on the Juniper, forming the common "cedar apple." It can usually be traced to the presence of a Juniper (Red Cedar) tree some place in the near vicinity and the trouble will disappear with the removal of the conifer.

There are many varieties of this rust, all belonging to the genus Gymnosporangium. They are of especial interest to students as their life histories are as yet incompletely worked out.

Branch of Maple Tree showing characteristic injury of the fungus Nectria. Natural size.

Scab.

This is a common disease of the apple and pear, attacking the leaves, twigs and fruit. Young foliage is sometimes dwarfed and even killed. If the attack is early in the season the small fruit may be entirely destroyed.

The fungus causes dirty, greenish spots on the fruit. The skin scales up and cracks appear, making the fruit unsightly and less marketable. Bordeaux should be applied before the buds open and again after the fruit sets and at intervals of a few months until the danger from the disease is past.

Sooty Fungus.

This disease causes the fruit to appear speckled, as with a thin coat of soot or fly specks, and is caused by "Leptothyrium pomi," a minute fungus. The quality of the fruit is not injured but it is rendered less marketable. The spraying for anthracnose will probably be all that is needed to prevent the disease.

Blackberry.

Anthracnose.

This is sometimes a common disease on blackberry canes, causing small sunken white spots. On infested plants the fruit dries up before it has an opportunity to ripen and eventually the entire cane dies.

It is caused by the same fungus which produces the anthracnose on the raspberry. All infested canes should be carefully cut out in the fall and the remaining canes sprayed in the winter or early spring with a strong Bordeaux solution, or with a solution of copper sulphate in water, at the rate of five pounds to twenty-five gallons of water.

Crown Gall.

Occasionally we find blackberry plants which develop large galls at the point where the stem and the root join. Occasionally these galls extend down onto the roots for some distance, but seldom appear above the surface of the soil. Their exact nature has not been satisfactorily determined, but it is probable that they are closely related to the Crown Gall on the apple, which is produced by bac-

terial action. The remedy is to dig out and burn all infested plants and, if possible, change the location of the blackberry beds to fresh soil.

Rust.

The Orange Rust of the blackberry is a common disease, widely distributed both among cultivated and native plants.

The bright orange-red spores are produced on the leaves and the young shoots in the summer and are often widely distributed by the wind. The disease is so conspicuous that it can readily be recognized and cut out in the summer time and the infested parts destroyed by burning.

The Bordeaux or the copper sulphate treatment, as recommended for the anthracnose, would have a tendency to prevent damage by Orange Rust.

Cherry.

Black Knot.

See Plum.

Shot-Hole Fungus.

In spring the leaves of the cherry are often damaged by a fungus which causes them to become spotted with brown. These spots later cause the death of the tissue and the leaf substance falls out, making a number of small, round perforations in the leaf. The appearance is that of having been shot with a shotgun.

As soon as the disease appears the trees should be sprayed with dilute Bordeaux solution and the spraying repeated at intervals of a few days. If this practice is adopted as soon as the leaves start to become spotted the disease can often be completely controlled. Otherwise the trees will be defoliated.

Brown Rot.

This is not usually a very common disease in Indiana, but it may become very destructive.

The affected fruits dry up and many of them remain on the tree until the fall season. It is on these dried fruits that the fungus lives during the winter to supply spores for a fresh infestation the following season.

As a means of prevention the affected fruit should be carefully gathered and destroyed and the trees should be sprayed with strong Bordeaux solution before the buds open in the spring.

The same fungus also affects the plum, causing what is commonly known as Brown Rot on that fruit.

The disease less frequently attacks the fruit of the apple, where it can be dealt with as indicated for the cherry disease.

Cucumber.

Wilt.

This is a disease of cucumbers, melons and squashes that is caused by the presence of a bacteria growing in the tissues of the plant. The water supply is eventually cut off and the vines die for lack of moisture. It is a very difficult thing to control and the only practical treatment is the extermination of the trouble by gathering and burning all affected vines.

Grape.

Brown and White Rot of the grape are both caused by fungi whose spores pass the winter either on the vines or in the dead leaves and trash on the ground surrounding the vines.

The vineyard should be carefully cleaned up in the fall; all fallen leaves, rubbish, and trimmings should be carefully carried out and burned. The vines should then be sprayed with strong Bordeaux mixture. This spraying should be repeated before the buds open in the spring. Systematic treatment of this kind will probably do away with most of the fungus troubles of the grape, but should they reappear the young fruit can be sprayed repeatedly with dilute Bordeaux.

If to this solution is added the proper quantity of paris green the spraying can be made effective for the Grape Berry moth as well as for the fungus.

Maple.

The native hard maples, when planted along the city streets, are often subject to leaf blight. This disease, by annual recurrence, often results in the serious damage, if not the death, of the tree.

Shortly after the foliage is fully developed the leaves wilt and

turn brown, but do not immediately fall from the tree. Often only a portion of the leaf will be affected and sometimes the disease will be confined to some distinct portion of the tree, recurring in the same place year after year.

Brown Rot of Grapes.

Where this disease occurs we may invariably look for some prior damage, either to the tree itself or to the root system. One tree that I have been able to observe for the last ten years has each season been affected with this disease until all of the branches from one side of the tree are now dead. At about ten years ago there were several large limbs taken from this side of the tree and a

large area of bark destroyed by a passing wagon. It would seem that this disease could be directly traced to this injury, as prior to that time the entire tree had been healthy. In Princeton, Indiana, I noticed a long row of hard maples, all of which showed considerable of this leaf blight. The street at this place had been regraded and cut down about a foot around the trees, leaving each tree in the center of a small mound. All of these trees were diseased, while trees on the opposite side of the street, where the grade had not been interfered with, were normally healthy.

The conclusion to be drawn is simply that our native hard maples should not be planted in any situation where the root systems are likely to be interfered with or where they will not receive a normal supply of moisture. These conditions make it, as a rule, an unsatisfactory tree for city planting.

Peach.

Crown Gall.

This disease is not nearly so common on peach stock as it is on apple, but wherever it is found it should be treated as recommended for apple crown gall.

Leaf Curl.

During cool, moist springs this leaf trouble on the peach often becomes very serious. The season of 1908 was particularly noticeable in this regard. Practically all of the seedling trees in the State lost most of their leaves through this disease. It was noticeable that the trouble was much less severe on budded stock.

The disease can be controlled by spraying with strong Bordeaux solution or a solution of five pounds of copper sulphate in twenty-five gallons of water before the buds open in the spring. Bordeaux solution must not be used on peach foliage.

Peach Yellows.

This is a serious peach disease of unknown cause that must be treated by the removal and burning of all infested stock. It is characterized by the early ripening of the fruit, which is often marked by red streaks radiating through it from the center. Often there is excessive branching of new shoots producing great bunches of slender, wiry twigs. The color of the foliage is also usually of a

pale, sickly yellow and the leaves are inclined to fall prematurely.

Spraying has no effect on this disease and our remedy is to cut out and burn the infested trees. When this disease is known to exist in a given locality we will make an effort to prevent the growing of peach stock in that locality as it is recognized that the trouble may be distributed on the young trees.

Brown Rot.

This fungous disease of the fruit is a difficult one to control, owing to the fact that peach trees cannot be sprayed with Bordeaux solution after the leaves are out.

The preventive measures suggested for the Brown Rot of the cherry will apply equally well in this case. It is possible that the self-boiled lime-sulphur solution may develop into a useful fungicide for all peach diseases, though our experiments in this direction are not yet conclusive enough to warrant their publication at this time.

Pear.

Blight.

In this disease the branches wilt and the foliage turns dark, but does not fall from the tree. It is caused by a specific bacteria and is contagious from one tree to another. It can be checked and eradicated by thoroughly cutting out and burning all affected parts.

The instruments used for trimming blighted trees should always be thoroughly sterilized before using them on healthy trees as the disease may, in this way, be transferred. All wounds made by trimming pear trees should be carefully painted over with some persistent antiseptic. Coal tar is excellent for the purpose.

Pear blight, as a rule, shows a tendency to attack the more thrifty, tender growth. Cultivated orchards are notably more subject to the disease than neglected orchards are. The cultivation produces an extensive growth which is naturally not so hardy as the growth produced in a neglected orchard. For this reason it is good orchard practice with pears to refrain from cultivation and to trim no more than is absolutely necessary. Some varieties are less subject to tree blight than others and this fact has made the Kiefer pear the leading commercial pear in this district.

Branches of Plum Infested with Black Knot.

Plum.

Brown Rot.

See Cherry.

Black Knot.

This disease is caused by a fungus infesting the branches and causing unsightly excrescences to form along them. The disease is contagious and very destructive and the only satisfactory method of control is to cut out and burn the infested branches. This treatment will sometimes save a tree if it is adopted early enough in the progress of the disease. A tree that is badly infested had better be cut down and the entire trunk and branch system burned.

Like the pear blight this disease is more liable to attack certain varieties than others. It is notably severe on all varieties of the Damson plum, while the Japan plums are usually quite free from it.

Shot-Hole Fungus.

See Cherry.

Raspberry.

Anthracnose.

This fungus is sometimes so severe in its attacks on the raspberry that it renders its successful cultivation practically impossible. It occurs on the young canes as round, purplish spots and winters in the spore condition on the dead wood. Thorough cutting out of all affected stock and spraying the remainder well with Bordeaux would probably be effective in checking damage done by this pest. It is almost impossible to propagate young plants from stock that is affected with anthracnose.

The accompanying illustration is a sufficient basis for the identification of this disease.

Raspberry Stem affected by Raspberry Anthracnose.

Wheat.

Rust.

This fungus (Puccinia Graminis) is difficult to control. In regions where it is very common wheat growers are trying to select varieties of wheat that are rust proof. There are no suggestions as to its control.

Stinking Smut.

This fungous disease is sometimes very destructive to wheat, but can be prevented by employing the formalin treatment as outlined in the division on fungicides.

Strawberry Leaf affected by Strawberry Leaf Blight.

Inspecting for Bee Diseases.

BEE INSPECTION.

Early in the summer of 1908 my attention was called to the fact that the State Bee-keepers' Association was interested in securing a law for the appointment of a State Inspector of Apiaries. I at once suggested to the legislative committee of this association the advisability of having the work of Bee Inspection directed from the office of the State Entomologist and thus save the State the expense of a separate organization. They quickly grasped the value of the suggestion and together we have prepared an outline for a law covering this matter.

The following bill was drafted after a careful study of the laws of other States, and it is the general belief that this measure possesses articles of strength not possessed by acts of other commonwealths:

An act to provide for the more extensive duties of the State Entomologist. —Defining those duties.—Making an appropriation therefor and declaring an emergency.

Section 1. The State Entomologist, or his properly appointed deputies, shall be and is hereby constituted State Inspector of Apiaries, and as such inspector it shall be his duty to aid and assist in the development and protection of the bee and honey industry in this State and to adopt and carry out proper measures for the prevention and suppression of contagious and infectious diseases among bees.

Sec. 2. Said State Entomologist shall have full power and authority, at his discretion, to visit and examine any apiaries for the purpose of discovering whether or not any disease may exist among bees in any part of the State. When notified of the existence, or the probable existence, of Foul Brood or other contageous or infectious diseases among bees in any apiary in the State, he shall visit and examine said apiary so reported, and all other apiaries in the same neighborhood, that he may be informed about, for the purpose of determining whether such disease exists or not. And whenever he shall be satisfied of the existence of Foul Brood or other diseases in their malignant form in any apiary, it shall be his duty to order all colonies so affected, together with hives occupied by them, and the contents of those hives, and all tainted appurtenances that cannot be disinfected and that might cause the further spread of the disease, to be immediately destroyed by fire under his personal supervision and care, but where said Entomologist, who shall be the sole judge thereof, shall be satisfied that the disease exists in milder types and incipient stages and is being or may be treated successfully, and he shall have reason to believe that it may be entirely cured, then he may in his discretion, omit to destroy or order the destruction of the colonies or hives in which the disease exists. Whenever the disease shall be found to exist and the treatment shall be ordered for the same by the State Entomologist, he shall give to the owner or person in charge of such apiary, instructions as to the manner of treat-

ment of such apiary, and to see that such treatment shall be carried out, and should the said owner or person in charge of said apiary refuse or fail to carry out the said instructions to the complete eradication of the disease or the satisfaction of the State Entomologist, he shall order all said diseased colonies to be destroyed by fire as provided for in case of disease in its malignant form.

Sec. 3. The State Entomologist shall have full power in his discretion, to order any owner, possessor or person having charge of bees dwelling in box hives or apiaries where disease exists (having mere boxes without frames) to transfer such bees to movable frame hives within a specified time, and in default of such transfer he shall destroy or order the destruction of such box hives and the bees dwelling therein.

Sec. 4. Said State Entomologist shall have the right to enter upon any premises where bees are kept, for the performance of his duties.

Sec. 5. The State Entomologist shall include in his annual report to the Governor such information in regard to the work of the apiary inspector and bee culture as he may deem of importance to the State.

Sec. 6. Any owner of an apiary where disease exists or any person or persons, company or corporation, who shall sell, barter or give away or import into this State any colony or colonies of bees or appliances infected with disease, or expose to the danger of other bees any comb, honey, bee hives or appliances, or other things infected with disease, or conceal the fact that disease exists among his bees, when disease is known to exist, or refuses to allow the State Entomologist to inspect or treat any apiary or appliances, or shall resist, hinder or impede him in any way in the discharge of his duties under the provision of this act, shall be guilty of a misdemeanor and upon conviction shall be fined in any sum not less than ten nor more than twenty-five dollars.

Sec. 7. Every bee-keeper or other person who is aware of the existence of Foul Brood or other infectious or contagious diseases, either in his own apiary or elsewhere, shall immediately notify the State Entomologist of the existence of such disease and in default of so doing shall be guilty of misdemeanor and upon conviction shall be fined in any sum not more than ten dollars.

Sec. 8. "Apiaries" within the meaning of this act shall be any place where one or more hives, swarms, or colonies of bees shall be kept.

Sixteen States and Territories already have laws relative to bee inspection, and a material advance has been made toward controlling the bee diseases in those States.

In New York alone the annual loss from bee diseases has been reduced from nearly $40,000 in 1899, to less than $2,000 in 1905, the last year of which I have data.

Before lending my aid to this movement in Indiana I investigated the conditions enough to know that the Foul Brood disease positively did exist in the State and that a condition prevailed that would result in very decided financial loss unless some measure was adopted to check it. It is difficult to present figures showing what this loss would amount to and I will not attempt to do so, though

it can readly be understood that the loss resulting from the death of a colony of bees is a loss that is far-reaching. It becomes cumulative in its effect, for not only must money value of the hive be considered, but also the products of that hive through successive seasons. Then, too, there is the effect on the manufacturer and dealer in bee-keepers' supplies, which is a very considerable industry at present. With a reduced supply of honey the price of that delicacy will naturally rise. In Indiana the number of apiaries is decreasing, though at no time did the State support the number of colonies which its size would warrant. In view of all these facts the State would certainly be justified in appropriating money to render bee inspection possible and to encourage an industry that is capable of adding very materially to our State wealth.

There are two diseases of bees in America that are known to be contagious. They are known as American and European Foul Brood. The American disease is caused by an organism known as Bacillus larvae and it is this disease which exists in this State—though a complete investigation will doubtless reveal the presence of European Foul Brood also. These diseases have both been carefully described and studied by Dr. E. F. Phillips of the U. S. Department of Agriculture and his description of the diagnostic symptoms follow:

AMERICAN FOUL BROOD.

"When the larvae are first affected they turn to a light chocolate color and in the advanced stages of decay become darker, resembling roasted coffee in color. Usually the larvae are attacked at about the time of capping and most of the cells containing infected larvae are capped. As decay proceeds these cappings become sunken and perforated and, as the healthy brood emerges, the comb shows the scattered cells which contain larvae that have died of the disease, still capped. The most noticeable characteristic of this infection is that when a small stick is inserted in a larva which has died of the disease, and slowly removed, the broken-down tissues adhere to it and will often stretch out for several inches before breaking. When the larva dries it forms a tightly adhering scale (of characteristic and diagnostic shape and) of very dark brown color, which can best be observed when the comb is held so that a bright light strikes the lower side wall (of the cell). Decaying larvae which have died of this disease have a very characteristic odor which resembles a poor quality of glue. This disease seldom attacks drone or queen larva."

EUROPEAN FOUL BROOD.

"This disease attacks larva earlier than does American Foul Brood and a comparatively small percentage of the diseased brood is ever capped. The diseased larvae which are capped over have sunken and perforated cappings. The larvae when first attacked show a small yellow spot on the body near the head and move uneasily in the cell. When death occurs they turn yellow, then brown, and finally almost black. Decaying larvae which have died of this disease do not usually stretch out a long thread when a small stick is inserted and slowly removed. Occasionally there is a slight ropiness, but this is never very marked. The thoroughly dried larvae form irregular scales which are not strongly adherent to the lower side of the cell. There is very little odor from decaying larvae which have died of this disease, and when an odor is noticeable it is not the glue-pot odor of the American Foul Brood, but more nearly resembles the soured dead brood. This disease attacks drone and queen larvae very soon after the colony is infected. It is, as a rule, much more infectious than American Foul Brood and spreads more rapidly. On the other hand it sometimes happens that the disease will disappear of its own accord, a thing which the author never knew to occur in a genuine case of American Foul Brood. European Foul Brood is most destructive during the spring and early summer, often almost disappearing in late summer and autumn."

Both diseases are decidedly infectious and in diseased colonies practically every part of the hive with which the bees come in contact becomes contaminated with the germs and is a source of infection to healthy bees. An infected colony should be shaken into a new hive and the queen caged in with a bit of queen-excluding zinc. The old hive should then be carefully cleaned and burned out with a gasoline torch. The honey should not be fed back to the bees till after it has been boiled for forty-five minutes, and it should be diluted with water before boiling.

With the passage of a good bee inspection law, such as outlined above, the honey industry should develop into a branch of agriculture in this State. There seems to be no limit for the demand for honey at a good price, while the work that bees do in the matter of pollenation possesses an economic value impossible to calculate. In this way they have a direct bearing on our great and growing horticultural interests. *Indiana's bees are an important asset. We must protect them.*

Fifteen-Year-Old Norway Spruce Along a Fence Row.

WINDBREAKS.

The question of windbreaks is one that has, heretofore, not bothered the Indiana farmer, but with the continued destruction of our forests we find greater and greater stretches of bare fields for the wind to sweep across. As a result we have greater damage from cold in winter and more extensive and injurious drouths in summer.

During the past year I have often been asked for suggestions relative to trees to plant for shelter belts and windbreaks and the question seems to be of enough importance to our horticultural interests to warrant a brief discussion in this report.

While nearly every farm will present its individual problem as to where and how to plant a windbreak and what trees to make it of, there are some general questions that may serve as a guide to the prospective planter.

In the first place we must consider the direction of the damaging winds. Over the most of the State these will be found to come from the southwest, so that our windbreaks will be planted on the west and south. In the northwest counties the worst winds come down from the northwest and windbreaks must be planted accordingly.

If the windbreak is to be planted on broken ground that is liable to wash badly, then it should cover a wider strip of territory and constitute a shelter belt. Such a planting, made of carefully selected trees, will not only prove a windbreak, but will eventually yield good returns in forest products such as fence posts and fuel.

TREES TO PLANT.

Norway Spruce.—If only a narrow strip of land can be afforded on which to plant a windbreak no better tree can be chosen than the Norway spruce. It is perfectly hardy and grows fast enough to keep pace with the average apple orchard. If a single row is planted the trees can stand six feet apart, but if a double row is set out the trees should be placed eight feet apart with a similar or greater distance between the rows. The rows should not stand exactly opposite, but should overlap so that a tree will be presented to the wind every four feet. This system of planting is the best, not only for quick results, but for permanent effectiveness.

The spruce (or other evergreen) has the advantage that it does

A Row of White Maples, about Twenty Years Old, Planted for a Windbreak.

Double Row of White Maples Planted for Windbreak Purposes.

not harbor any insect pests liable to be injurious to fruit trees. They will grow on any well drained soil.

Soft Maple.—In some sections the soft maple has proved to be a good windbreak tree. It is fully as effective as any tree, not an evergreen, and grows rapidly. It will stand more moisture and less poor soil than the Norway spruce and will grow more than twice as fast. Both the San Jose scale and the Cottony Maple scale are serious pests on this tree, and both must be considered as possible enemies to fight when the tree is planted. No deciduous trees should be planted in a belt of less than two rows.

Catalpa.—I have written so much on the virtues and vices of catalpa that I hesitate to mention the tree in this connection at all. As is commonly known, there are two species of catalpa; one admittedly worthless save for ornamental purposes and for fuel, and the other supposed to be exceedingly valuable for all purposes for which wood is used. So far as I have been able to learn from actual observation the value of this "good" kind, *Catalpa speciosa,* has been vastly overestimated. For windbreak purposes any kind of catalpa, however crooked, will prove valuable, and in time furnish a certain quantity of fuel. All members of the genus grow rapidly, though not so rapidly as the soft maple, the white willow, or the American chestnut. Catalpa should never be planted unless several rows can be placed side by side, as the branches are too coarse to provide much wind resistance when the leaves have fallen. Comparatively few insects bother the catalpa—none of them are liable to attack fruit trees.

For good results the catalpa must have rich soil. It is a failure on poor hill land and should never be planted in such a situation. For a windbreak the trees should be planted in rows eight feet apart and the trees should stand close together in the rows—as close as eighteen inches from tree to tree. This will allow of plenty or light between the rows to promote rapid growth and the trees will be thick enough to make considerable resistance to the wind.

White Willow.—If it is desired to have a windbreak along the bank of a stream the White Willow will be found a rapid grower and an excellent shelter tree. It will serve the additional purpose of preventing the washing away of the bank in time of floods. No other tree is so valuable as the willow for just this purpose.

The young trees can be readily started in the spring by making cuttings from the older trees. They will start best in sand and after they have become well rooted they can be transplanted to their permanent location.

A Catalpa Planting showing the characteristic crooked growth of this tree. For windbreak purposes the trees should be planted closer together than is shown.

Chestnut.—The American chestnut is one of the best trees that can be planted for shelter belts, though it is, like the catalpa, more effective when several rows are planted.

Unless they have plenty of light the lower limbs of the chestnut soon die and fall off, so that it is advisable to allow more space between the trees and to plant the rows farther apart. A spacing of four feet by ten will produce a rapid growth and furnish considerable shelter. A single row of chestnut trees planted in the open will form a low head and will afford shade and wind shelter while in foliage. Their value as a winter wind-break is immaterial.

The chestnut is adapted to a variety of well drained soils and will make a rapid growth. It is, however, a difficult tree to transplant, and it is better to secure a stand by planting the nuts where the trees are to remain. The nuts for planting should be gathered in the early fall and stored over the winter in *moist* (not wet) sand. The chestnut is not subject to many insect enemies and none of the few which occasionally bother it have any affinity for fruit trees.

At the age of fifteen years a windbreak of chestnut trees should begin to yield some return in the way of fruit, for which there is always a ready sale.

At the same age the trees could be thinned to a certain extent, yielding first class fence posts as durable (when seasoned) as white oak.

Osage Orange.—This tree was formerly widely used as a hedge plant, but the advent of the cheap wire fence has rendered it obsolete. The tree had a native range from Missouri to north Texas, where in places it formed almost impenetrable forests.

It is a rapid grower and soon makes an effective windbreak. There are, however, some important objections to its use. In the first place its long roots rapidly deplete the soil for some distance from the plant, thus exerting a perceptible effect on the adjacent crops.

Then, too, the tree is subject to a serious infestation of the San Jose scale. It is probably no more attractive food for the scale than some other trees used for windbreaks, but the San Jose scale on an Osage hedge as a windbreak is of more significance simply because birds love to nest in the thorny trees—and birds are the great scale distributors.

The Osage orange thrives on a great variety of soils. The wood is extremely hard and is practically indestructible. I know of no wood more durable in contact with the soil and I have yet to see a rotten piece of Osage.

A Single Row of Chestnut Trees Planted Twenty-Three Years.

A Johnnie Appleseed Tree.

BY MRS. M. E. S. CHARLES, SPICELAND, IND.

When the early settlers came to the southern part of Henry county they found evidence that they had been preceded by at least one man.

On the farm now owned by Samuel Hoover, northwest of Spiceland, in a piece of original forest, stands the stump of an apple tree, as shown in the illustration, which was bearing fruit as early as 1830. Josiah T. Unthank, now past seventy-one years of age, with other boys of early times, frequently ate apples which grew on this tree. Mr. Unthank says that in quality the apples were very poor compared with what we have now, but to the boy of that time they were rare fruit.

This tree was a sprout from the original tree, the seed from which it grew having been planted, as is supposed, by John Chapman, better known as Johnnie Appleseed. A part of the trunk of the original tree is also shown in the picture.

Johnnie Appleseed was a pioneer horticulturist. With a bag of carefully prepared apple seeds on his back, and with mattock or broad-bladed pickax in hand, he traveled on foot through the dense forests of Ohio and Indiana planting apple seeds. With his mattock or pickax he dug out the saplings and planted the seeds in the soft mold. After the planting was done he built a rude fence of brush around the space to keep the deer from browsing on the young trees. In this way he spent year after year, often covering a thousand miles in one season. When the first settlers came many of the young trees were planted in their small clearings.

The various Indian tribes considered Johnnie Appleseed their benefactor, and each tribe regarded it an honor for him to accept their hospitality when passing through their territory. He was a devout Christian and would stop and read from the Scriptures to the dwellers in log cabins. Often he went barefoot and otherwise scantily attired, but he was always ready to divide his limited supply of clothing with those poorer than himself, and such opportunities were often afforded among early settlers.

L. H. Bailey's Horticultural Encyclopedia says he died in 1847, after having walked the wilderness planting apple seeds for forty-six years. Considered crazy by many while living, his memory is to be perpetuated by a marble monument.

A Johnnie Appleseed Tree in Henry County, Indiana.

A New Fruit Grown by Ben Knaub of North Vernon, Indiana.

A "Burbank" Experiment.

I was interested in an experiment in grafting which has been carried on by Mr. Ben Knaub, of North Vernon, Ind. Several years ago Mr. Knaub grafted a Kiefer pear on an Osage orange stock. This graft grew and bore one fruit and died and from the single fruit Mr. Knaub now has a seedling tree about fifteen feet in height. This year the tree had a single fruit, of which the accompanying cuts give a good idea. The "pear" was almost globular in form, the skin texture was more that of the Osage orange, and there remained no trace of the calyx lobes. The flesh was coarse and had but little flavor; the seed cavities and seeds resembled similar parts of the pear. The fruit was very late in ripening. The incident is interesting from a purely experimental standpoint even though it failed to add a fruit of practical value to our horticultural lists.

In peach breeding Mr. Knaub has been more successful, having had several new varieties registered at Washington this year.

Pear Orchard in Southern Indiana Showing the Crop Ready to Ship.

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